PACIFIC HERRING RESEARCH, S.E. ALASKA

Completion Report for the Period July 1, 1986 to June 30, 1991

By

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ABSTRACT

The Alaska Department of Fish and Game conducted 129 hydroacoustic surveys, analyzed 31,173 fish for age, weight and length data, and made biomass assessments from 36 spawn deposition surveys on herring (*Clupea harengus pallasi*) stocks throughout Southeast Alaska from the fall of 1986 through the spring of 1991. Areas surveyed included Kah Shakes, Cat Island, Craig, Anita Bay, Port Camden, Seymour Canal, Juneau, Tenakee Inlet, Sitka Sound, Hoonah Sound and Lisianski Inlet, with priorities established by action of the Alaska Board of Fisheries. Hydroacoustic estimates were made using Department vessels with samples for age-weight-length analysis taken from either the spawning grounds, the commercial fisheries, or from mid-water trawling during hydroacoustic surveys. Egg deposition biomass surveys to assess herring escapements and to document spawning ground conditions were made using SCUBA, with the total biomass of spawning herring computed from estimates of egg densities related to the area receiving spawn.

INTRODUCTION

The abundance of herring (*Clupea harengus pallasi*) in Southeast Alaska exhibits wide fluctuations from year to year. In order to monitor these changes, a data base reflecting abundance, age structure, and spawning success is required to manage the resource.

The goal of this project was to provide biological data necessary for the scientific management of herring stocks by the Alaska Department of Fish and Game (ADF&G) throughout Southeast Alaska. Objectives required to accomplish this goal are as follows:

1. Refine and develop hydroacoustic equipment to make reliable herring biomass estimates.

2. Conduct biological sampling in Southeast Alaska for age and growth analysis to determine stock conditions.

3. Develop, conduct, and evaluate spawning ground success to provide life history information and spawner biomass data to use as a comparison to hydroacoustic estimates, and as a basis for establishing commercial harvest quotas.

4. Conduct in-season management responsibilities as required.

Fishery Description

The Southeast Alaska Region is a composite of two herring statistical areas. Area A, the Southeast Alaska Area, encompasses the waters of Alaska south of Cape Fairweather and north of the International Boundary at Dixon Entrance. Area D, the Yakutat Area, extends west from Cape Fairweather to Cape Suckling (Figure 1). Commercial winter bait, sac roe, spawn on kelp, fresh bait pound and tray pack pound fisheries occur in the Southeast Alaska Area. Only a winter bait season is provided by regulation in the Yakutat Area.

Pacific herring stocks are found throughout the Southeast Alaska Region (Figure 2). These herring stocks vary greatly in size and productivity. In general, the stocks that spawn on the outer coastal areas are more productive than stocks that spawn in the inside waters. Southeast Alaska herring stocks have been commercially harvested since a salting operation was in initiated the 1880's. From the 1890's to the mid-1960's the catch was used primarily to supply herring for reduction to meal and oil. The reduction fishery occurred on mixed stocks of feeding herring during the summer months. The reduction fishery production peaked during the 1920's and 1930's when annual harvests commonly exceeded 50,000 tons (Table 1). The reduction industry was phased out in the mid-1960's due to a decline in the abundance of herring combined with the development of the Peruvian anchovy reduction industry.

Southeast Alaska herring stocks have historically supplied most of the bait for Alaskan commercial longline and crab fisheries. This harvest occurs during the fall and winter months, a time when bait quality is best, on discrete wintering schools in major bays and inlets. Most of the bait harvest is taken by purse seine gear. During this 5 year reporting period, herring have been taken commercially for bait from Bocas de Finas and Meares Pass near Craig, Slocum Arm, Tenakee Inlet and Lisianski Inlet (Figure 3).

Currently, most of the annual herring harvest is taken during the spring sac roe fishery which developed in the early 1970's. The sac roe fishery takes herring immediately prior to spawning when egg maturity is highest and the product has the greatest value. The fishery utilizes purse seine gear in Sitka and Juneau, and gill net gear in Kah Shakes and Seymour Canal (Figure 4).

A wild, spawn-on-kelp fishery occurred during the 1960's; however, this fishery was phased out in the early 1970's. A new herring spawn-on-kelp pound fishery, approved by the Alaska Board of Fisheries, began in the spring of 1990 in Hoonah Sound and occurred in 1991 as well (Figure 5).

A fresh bait pound fishery, with quotas set by the Board of Fisheries, is the smallest of the commercial fisheries in Southeast and has areas open to fishing in Scow Bay, Farragut Bay, Sitka Sound, Tee harbor, Indian Cove, and Lisianski Inlet (Figure 6). Catches in the bait pound fishery are low, with few participants.

The commercial utilization of Southeast Alaska herring resources is very controversial. Although the subsistence and personal use harvest levels are a minor portion of the total annual take, these uses are considered important to local residents. The commercial harvesting is viewed by much of the public as having a great impact on the local availability of herring. Additionally, herring are a major forage fish and their abundance is viewed as necessary to ensure healthy populations of predatory fish such as salmon and halibut.

HYDROACOUSTIC ASSESSMENT OF SOUTHEAST ALASKA HERRING STOCKS

Objective

Refine and develop hydroacoustic equipment to make reliable herring biomass estimates.

Procedures

Hydroacoustic survey and assessment techniques enable researchers to conduct biomass assessments of herring concentrations while the fish are in deep water, generally in wintering or pre-spawning congregations. Hydroacoustic surveys of pacific herring populations have been conducted in Southeast Alaska since as early as 1971 and are the subject of ongoing research worldwide as well as in Washington, Canada and Southeast Alaska. In Southeast Alaska during the late 1970's and 1980's, the standard hydroacoustic data acquisition system for most surveys was based on a modified 105 KHz Ross 200A echosounder. Signals from the echosounder were heterodyned to 5 Khz and recorded on analog magnetic tape, in this case a Teac tape recorder,model 4070g, for later analysis. The signals from the receiver and echosounder could be viewed with the assistance of a Phillips Model PM3233 oscilloscope. The acoustic system used since 1988 includes a calibrated modified Ross 200A echosounder, a Sony Model PCM-F1 audio digitizer, plus a Sony SL2001 Beta machine to record and store audio signals. The system operates at 150KHz with a 7° circular transducer. The advances in technology produced a much cleaner signal of desired targets with a larger dynamic range. It is anticipated that the Department will upgrade the current hydroacoustic system again within the next year. Plans are to incorporate the newer Biosonics Model 101 echosounder and Biosonics Model 171 interface with the current acoustic gear now employed. In conjunction with a Biosonics Model 121 integrator, acoustic signals could be analyzed on-board by Department personnel, allowing real-time estimates.

Hydroacoustic surveys are conducted in known herring concentration areas from October through May, with November and March as targeted time periods. Two biologists working full time, plus support from area management biologists, are required to conduct the surveys. Surveys require defining an area that encompasses a herring concentration. These areas are generally within traditional wintering or pre-spawning staging areas with the exact boundaries determined by searching with sonar. A series of assessment surveys are then conducted on the area of herring concentration. The vessel records the hydroacoustic signals reflected back from the fish over a series of transects spaced evenly over the area. Density is determined by integrating the strength of the returning signal by water depth and converting to pounds with a herring signal strength standard. The area is determined from measuring the surface area transected. During surveys, mid-water trawl samples are also conducted to determine size, age, and species composition of targets observed. The Department presently has one mid-water trawl with a 30 ft. x 30 ft. opening, equipped with a Furuno Model FNR-200 Mark II net recorder. After the surveys are completed, the magnetic tapes are analyzed by echo integration within the Department or via contract with the University of Washington, or the Biosonics Corporation. In certain instances where accurate computer analyzed surveys are not possible due to herring distribution, visual estimates are made by experienced observers.

Results

Herring stocks throughout Southeast Alaska were acoustically surveyed from the *R/V Steller*, a 72' vessel owned by the Department, or visually estimated from one of the other Department vessels during November through April. The standard used to determine the portion of herring to include in the estimate of mature herring spawning biomass is any fish greater than 185 mm standard length. Smaller herring were not included in the mature biomass estimate. During the contract period we analyzed 72 hydroacoustic surveys with the aid of the computer and made visual estimates of 90 surveys of which there were 33 pairs of observations (Table 2). Detailed records were kept of specific herring survey locations to aid in relocating herring concentrations. The number of surveys computer-analyzed fell dramatically during the contract period from 27 in the 1986-87 season, to 0 for the 1990-91 season. The reasons for the decline in number of hydroacoustic surveys included an increased reliance on spawn deposition surveys as a more accurate estimate of the mature biomass, and the decreased time the manned vessels were available to the project. The comparability of visual and computer-generated estimates are fairly close when the size of the estimates are less than about 5,000 tons. However, as the computer estimate becomes greater, the observed difference between the computer estimate and the visual estimate also becomes greater (Figure 7). The true biomass in those cases is unknown, but several of the computer-generated numbers were much larger than anticipated. The accuracy of computer-generated hydroacoustic estimates is determined by several means, including a sampling program to determine the species targeted, and the size composition of the herring within the survey area. The proportion of a particular spawning stock within the survey area during the time of the survey and the chance that a wintering concentration may be composed of two or more spawning stocks complicates the reliability of hydroacoustic estimates. Point estimates, obtained by averaging the results of replicate surveys, and summing the estimates from distinct areas, are used as a best estimate of population size, and can be compared to estimates derived from spawn deposition estimates (Table 3).

Individual acoustical surveys often have a considerable variation between replicates. If sufficient effort is made, however, a reliable acoustical estimate is possible by using the average of several computer-assisted surveys of a known portion of a spawning stock, coupled with a sampling program that accurately describes the size of the fish measured. During this contract period we attempted to obtain accurate hydroacoustic estimates of the Craig area in 1988 and 1989, when the population was growing dramatically, and we were fairly successful. We were not successful in developing accurate estimates in most of the other areas because a large portion of the spawning stock could not be located prior to spawning (Kah Shakes, Sitka and Hoonah Sound), our sampling did not reflect the true age, size and species composition of the fish surveyed (Lisianski and Tenakee), or we did not expend sufficient effort (Seymour and Juneau). A comparison of average paired hydroacoustical and point spawn deposition estimates has a significant correlation, with an r-square value of .61 (Figure 8).

AGE COMPOSITION AND GROWTH

Objective

Conduct biological sampling on herring in Southeast Alaska for age and growth analysis to determine stock conditions.

Procedures

Field Sampling

Herring were collected during research surveys and the commercial fisheries from stocks throughout Southeast Alaska. Collection gear varied among locations and years, but included purse seines, cast nets, mid-water trawls and gill nets. Trawl samples were obtained using the *R/V Steller*. Small hand seines or cast nets were used when fish were sampled in shallow water during spawning. Sampling was conducted on the spawning grounds, and in pre-spawning, areas and wintering areas. Herring sampled from the commercial fisheries were collected from individual fishermen or tenders on the fishing grounds. During sampling, herring were generally collected from several different net sets and the time and geographic location of collection were recorded. Six-hundred fish from each stock was established as a target collection goal. All fish were either processed fresh, or they were frozen for examination and collection of scales in the laboratory.

Laboratory Methods

Immediately after thawing, the standard length (mm) of each fish, (tip of snout to posterior margin of the hyperal plate) was measured on a caliper measuring board. Fish were weighed to the nearest whole gram on an electronic balance.

A scale was removed from each fish to allow ageing of the fish. Scales were cleaned and dipped in a solution of 10% mucilage glue and water and placed unsculptured side down for permanent mounting on glass slides. Aging was conducted using a dissecting microscope, varying the light source for optimum image of annuli, or by using a Microfiche reader. Scale reading results were spot-checked by a second reader for age verification. The fish were assigned an anniversary date for each completed growing season. All samples were collected before growth had resumed in the spring. For example, if a herring hatched in the spring of 1986 and was collected in the fall of 1987, two growing seasons had occurred (age 2). If the herring had been collected in the spring of 1988 before growth had resumed, it was also recorded as age 2.

In order to supply rapid age frequency analysis, a field method utilizing plastic mylar was used. Approximately 100 herring were placed on a mylar sheet and standard lengths were marked with a soft lead pencil. Fish over 185 mm standard length were assumed to contribute to the spawning population; smaller herring were considered recruits. Subsequent hydroacoustic estimates of total biomass were pro-rated into pounds of mature and pounds of immature fish, accordingly.

Growth Analysis

The relationship between herring length (L) and age (t) was defined using the von Bertalanffy growth model (Funk and Sandone 1989):

$$L_t = L_\infty[1-e^{-K(t-t0)}] \quad (1)$$

The lengths used for modelling consisted of mean lengths-at-age for each unique combination of age, geographic location and gear type. The parameters, L_∞, K and t0 were estimated by weighted, non-linear least squares, weighting by the sample sizes associated with each mean length.

The relationship between mean weight and mean length was modelled using an allometric relationship:

$$W_l = aL^b \tag{2}$$

The model parameters a and b were also estimated using weighted, non-linear least squares, weighting by the sample size for each mean weight and length.

To define the relationship between $[W_t]$ and age (t), the models for the length-age (1) and weight-length (2) relationships were algebraically combined (Funk and Sandone 1989) to yield the model:

$$W_t = (aL_\infty^{\ b})[1-e^{-K(t-t0)}]^b \tag{3}$$

The term $aL_\infty^{\ b}$ is equivalent to the von Bertalanffy model asymptotic weight-at-age W_∞ parameter.

Results

A total of 31,173 fish were aged, sexed, weighed and measured for length. Samples were taken from Kah Shakes, Cat Island, West Behm Canal, Craig, Anita Bay, Port Camden, Seymour Canal, Juneau, Tenakee, Sitka, Hoonah Sound, Slocum Arm and Lisianski stocks (Table 4).

Age Composition

For all herring stocks in Southeast Alaska, with the exception of Seymour Canal, a dominant 1984 year class was present throughout this reporting period (Figures 9 - 18). In 1991, the 1988 year class first entered the spawning population as age 3 fish. There is strong initial evidence that 1988 will become a dominant year class.

Growth

The relationship between length and age was defined by the von Bertalanffy growth model with parameter estimates, $L_\infty = 262.4$, $K = 0.164$ and $t0 = -3.42$ (Figure 19). These parameter estimates yielded a good fit of model predictions to the data for ages 2 through 9. For ages greater than 9, the fit was not as good. Departure of the model predictions for age 9+ may be due, in part, to the much smaller sample sizes, with attendant lower precision and potential bias in estimates of mean length associated with these age classes.

Mean weight, as a function of mean length, was defined adequately by the allometric model with parameters $a = 1.02 \cdot 10^{-5}$ and $b = 3.04$ (Figure 20). Based on these estimates and the L_∞ from (1), the estimate of the von Bertalanffy asymptotic weight parameter, W_∞, was 239.

The relationship between mean weight and age was adequately defined by the von Bertalanffy weight-age model, particularly for the ages 2 through 9 (Figure 21). Model-predicted mean lengths for ages greater than 9 years tended to be greater than the estimated mean lengths. Again, small sample sizes for these older age classes resulted in greater variance in estimates of mean weight and may have contributed to a bias in the estimates of mean weight. Also, because weighted least squares, weighted by sample size, were used to obtain parameter estimates, mean weights associated with older age classes were less influential in parameter estimation, compared to the younger age classes. This weighting may have contributed to the divergence of model predictions and mean weights for the older age classes.

Modelling of these relationships provided estimates that will be used as benchmarks to monitor and detect future changes in growth, and in age-structured models to refine future stock assessments for Southeast herring.

SPAWN DEPOSITION SURVEYS

Objective

Develop, conduct, and evaluate herring spawning ground success to provide:

1. Life history information;
2. Spawner biomass data to use as a comparison to hydroacoustic estimates;
3. A population biomass estimate to use as a basis for establishing commercial harvest quotas.

Procedures

Specific areas receive herring spawn on an annual basis. They have become the foundation for herring stock definitions in Southeast Alaska. During this contract period, aerial and vessel surveys were conducted throughout the region to document spawn timing, and to provide an index of abundance in terms of the nautical miles of beach that received herring spawn. Aerial surveys were conducted on a periodic schedule to document the presence of eggs on intertidal kelp, milt present in the water, herring schools, and bird and sea mammal activity. In certain areas, skiffs were used to monitor the coastline or to collect similar information. Favorable weather conditions, experienced observers, low tides, and judicious allocation of the aerial survey budget were prerequisites to successful data collection.

The distribution of eggs within the spawning area, substrate type, and egg densities were determined from SCUBA (Self Contained Underwater Breathing Apparatus) egg deposition spawning ground surveys. This information was used as the basis for back-calculating the spawning biomass from the total egg deposition estimate.

Once the spawning area was defined by aerial and vessel surveys, transects were established along the beach from .25 to 1 nautical mile apart. Compass courses were set perpendicular to the shore with sampling at 5 meter intervals. Divers followed the compass headings from the upper intertidal zone to deeper water until spawn or vegetation disappeared. Data collected included depth, temperature, substrate type, and visual estimates of eggs within a 0.1 square meter frame. Underwater video recordings were also taken of substrate and sample collection activities for training new divers, and for visual aids in public meetings. Samples of substrate and eggs were collected for laboratory analysis to verify visual density estimates.

An underwater compass, a thermometer, and a depth gauge were permanently mounted on the .1 square meter sampling frame (made from perforated 3.4 in. diameter plastic pipe). The vegetation with attached egg samples was collected in small sample bags (approximately 2 liter capacity) for later hand counting in the laboratory. These kelp and egg samples were transferred from the diver's bag to 4 liter (1 gallon) size water tight zip lock bags and preserved in Gilson's fluid. Only a small amount, 1/4 to 1/2 liter of Gilson's fluid was added to a sample for preservation. Preserved samples were then taken to the laboratory for chemical separation and counting. The following is a detailed procedure for determining egg densities from collected samples.

1. Decant the Gilson fluid from the sample bags.

2. Add one normal KOH to the sample bag and mix thoroughly through the sample. Allow the sample to soak for 1.5 hours in KOH digestive hydrolysis. Placing the sample bag in a hot water bath accelerates digestion (eel grass can stand a strong digestion, while other kelps disintegrate quickly, impeding egg sorting).

3. Drain off KOH and place sample in a 4 liter (1 gallon) plastic bucket.

4. Repeated cold water washes of the sample to loosen the attached eggs. Decant and filter each wash through a fine mesh sieve. The majority of the eggs in the sample can be removed and collected from the filtrate.

5. The remaining eggs must be cleaned from the substrate by careful manual scraping. The loose eggs must be clean of kelp debris for accurate volumetric analysis.

6. Hand count and record all eggs that are lost or cannot be cleaned from the substrate.

7. The loose egg sample must be allowed to soak in 1.0 normal buffered formal saline solution for approximately 24 hours to assure a standardized volumetric displacement.

8. The preliminary step in quantitative analysis is to determine the standard displacement of 1,000 eggs. This is done by hand counting 1,000 eggs from a number of samples and determining the average displacement.

9. Hand count totals are added to the sample displacement and this figure is expanded by a factor of 10 to determine eggs/m^2 at each sample station. One technician can work up approximately six samples per day at a chemical cost of approximately $3.00 per sample.

Results

Comprehensive spawning ground surveys utilizing SCUBA were conducted in the Kah Shakes, Cat Island, Craig, Seymour Canal, Juneau, Tenakee, Sitka, Hoonah Sound and Lisianski areas at least once during this reporting period. The number of surveys has increased from five during 1987 to nine during 1991. Summaries of spawn deposition surveys by area comparing the egg densities, escapements, and resultant commercial fisheries quotas is calculated each year (Table 5).

During this contract period, a total of 300 paired underwater visually estimated and laboratory counted samples of vegetation with eggs was taken as a means of comparing the accuracy of egg counts by the type of substrate, and between divers, over time. A detailed analysis of this information found that between-diver, and year-to-year effects were not statistically significant, although substrate type affected the relationship between diver estimates and laboratory counts. Divers, on the average, underestimated egg counts at low egg densities and overestimated egg counts at higher densities (personal communication, F. Funk). The lack of individual diver affects was attributed to the training and experience of the divers. Individual Department divers have been assigned individual calibration figures that are applied to their field egg count estimates. These calibration figures were derived by taking the actual laboratory count of their collected samples and dividing them by their dive estimates. This calibration figure for a particular diver is then applied to his dive count when estimating the total egg deposition number.

The average amount of herring per nautical mile of beach for all areas surveyed each year has ranged from 800,000 lbs. in 1989 to 1,100,000 lbs. in 1987, with a total five year average of 900,000 lbs. (Figure 22). There was considerable variation between years for any one individual area, however. A three-fold difference between years was noted for Kah Shakes, Seymour Canal, Tenakee and Lisianski. Sitka Sound, with a five year range of values from 800,000 to 1,100,000 lbs., and Hoonah Sound with a four year range of 500,000 to 600,000 lbs., were much more consistent between years in the amount of herring that spawned per lineal mile of beach.

FISHERIES MANAGEMENT

Objective

Conduct in-season herring management responsibilities and document catches.

Procedures

This project is an integral part of the overall management approach for Southeast Alaska herring fisheries. It supplies biomass assessments and the basic life history information required to implement the Southeast Alaska management plan. This plan requires that a minimum spawning biomass or threshold level be met prior to allowing a commercial harvest. The harvest rate for a stock is dependent upon the size of the spawning biomass, and each stock is subject to harvest by only one gear type. Distinct herring stock units are specified for harvesting the winter bait and spring sac roe fisheries. A major management concern is to minimize the harvest of individual stocks that occur in both fisheries. Although some overlapping of fisheries probably does occur, it is not believed that there is significant "double dipping" on individual stocks.

A "threshold level" is the minimum herring biomass needed to ensure sustained yield and it is based upon recent stock performance and historical population levels measured as catches, biomass assessments, or miles of spawn. Threshold levels have been established for each of the winter bait, sac roe, and spawn-on-kelp pound stocks. These threshold levels are generally the same from year to year but have been changed from their original values for specific areas after evaluation of current stock conditions and performance. Current threshold levels vary from 4,000,000 to 15,000,000 lbs. for the major sac roe and winter bait stocks, to 2,000,000 lbs. for the Hoonah Sound spawn-on-kelp pound fishery (Table 6).

Herring stocks with a spawning biomass of less than 4,000,000 lbs., of which there are many, are not considered for harvest in either the Southeast Alaska winter bait or sac roe fisheries. Under the current approach for setting seasonal harvest limits, herring stocks of 4,000,000 lbs. would allow for an annual harvest of 200 tons of herring. The region's current management capability, combined with the highly competitive nature of these fisheries, make it impossible to successfully manage the winter bait or sac roe fisheries for harvests of less than 200 tons. In the Yakutat Area, a winter bait harvest of 100 tons has been allowed in previous years, but it now has a 2,000,000 lb. threshold.

Annual harvest limits are based on a graduated scale that allows for higher harvest rates as the herring population increases, relative to the threshold level. The scale provides for a uniform method for establishing harvest levels for each herring fishery. The approach allows for an annual harvest rate of between 10-20% of the mature herring if the established spawning threshold levels are satisfied. No harvesting is allowed if the biomass estimate for the stock is less than the threshold. When the estimate of the mature stock is at the threshold level a 10% harvest is allowed. The harvest rate increases 2% each time the estimated spawning biomass increases by an amount equal to the threshold level. The harvest rate reaches a maximum of 20% when the population is six times the threshold level (Figure 23).

The successful accomplishment of this management approach is dependent upon the determination of the size of the herring populations, the age and growth characteristics of the individual populations, and spawning success on a stock by stock basis. Biomasses for the Southeast Alaska winter bait and sac roe stocks were determined from egg deposition dive surveys over the past two years, with vessel hydro-acoustical surveys used in some instances when a spawn deposition survey was not available. In cases where spawning ground surveys were used, the estimate included only mature herring that spawned the previous season. It did not account for any mortality of the herring after the spawning occurred, nor did it include any additional recruitment that may have been realized since the surveys were completed. For those instances where the population estimate was derived acoustically, only those herring that would be expected to contribute to the spawn were included in the estimate. This was determined by sampling the population with trawl gear, analyzing the age and size structure, and including only the mature segment (standard length >185mm) of the population. Age and growth information was obtained by sampling through test fishing, commercial harvests, mid-water trawling, and sampling on the spawning grounds.

Support of the management programs throughout Southeast Alaska is vital to the successful conduct of the fisheries. Technical data support, hydroacoustic surveys, herring behavior observation, and fisheries experience are great assets to the area management staff.

Results

The commercial fishery in Southeast Alaska produced a 1986-87 seasonal herring catch of approximately 8,559 tons. This included a catch of 2,506 tons of winter bait herring taken from Craig and Tenakee, 5,988 tons of sac roe herring taken from Kah Shakes, Seymour and Sitka, and 65 tons of fresh bait sold from herring pounds taken from Farragut Bay and Sitka. Value to the fishermen was $600,000 for the bait product and $6,800,000 for the sac roe product.

The total 1987/1988 season harvest was about 15,267 tons. This was the highest regional harvest since 1964. The sac roe harvest contributed approximately 11,121 tons to this harvest with an ex-vessel value of $7,300,000. The catch of 4,129 tons in the winter bait fishery and 17 tons in the bait pound fishery was worth $1,000,000 to the fishermen. The sac roe fishery was open in Kah Shakes, Seymour Canal, and Sitka Sound. The winter bait season was open in Lisianski Inlet, Tenakee Inlet, Slocum Arm, and Craig, with the bait pound catch occurring in Sitka.

The total 1988/89 season harvest was 16,155 tons and became the new high regional harvest since 1964 with a total ex-vessel value of $3,500,000. The sac roe harvest totaled 12,973 tons for an estimated ex-vessel value of $2,530,000. The catch of 3,116 tons in the winter bait fishery and 66 tons in the fresh bait pound fishery was worth $1,000,000 to the fishermen. The sac roe fishery was open in Kah Shakes, Seymour and Sitka Sound. The winter bait season was open in the Lisianski Inlet, Tenakee Inlet, and Craig areas. The two fresh bait pounds operated in Sitka Sound.

The total 1989/90 season harvest was 8,059 tons for the bait and sac roe fisheries, and 11.8 tons of spawn on kelp. This decrease in catch was due primarily to a reduction in the Sitka Sound sac-roe quota, and the Kah Shakes gill net sac-roe area not being opened to fishing because it did not meet the required spawning biomass threshold level. This was the first year that the Hoonah Sound pound spawn on kelp fishery was conducted. The total ex-vessel value was $3,400,000. The commercial sac-roe harvest totaled 4,163 tons for an estimated ex-vessel value of $2,200,000. The catch of 3,843 tons in the winter bait fishery was worth an estimated $1,030,000 to the fishermen, and the spawn-on-kelp fishery with a harvest of 11.8 tons, was worth an additional $170,000. The sac roe fishery remained open only in the Sitka Sound and Seymour Canal areas. The winter bait fisheries were open in Lisianski Inlet, Tenakee Inlet, and in the Craig area. Fresh bait pounds in Sitka Sound contributed an additional 38 tons to the year's harvest.

The total 1990-91 commercial bait and sac roe harvest was 6,056 tons of herring, and 13.5 tons of spawn-on-kelp. This decrease in the catch from the previous year was due mainly to a reduction in the Sitka Sound sac-roe quota, and no fishery in the Seymour Canal gill net sac-roe area in 1990. The total ex-vessel value was $1,800,000 to the fishermen. The commercial sac-roe harvest totaled 2,568 tons for an ex-vessel value of $690,000. The catch of 3,272 tons in the winter bait fishery was worth $870,000. The spawn on kelp fishery was worth $210,000, and the fresh bait pounds, which harvested 65 tons of herring, had an estimated value of $60,000. The sac-roe fishery was open only in the Sitka Sound and Kah Shakes/Cat Island areas. The winter bait fishery was open in only the Craig area, with fresh bait pound catches occurring in Farragut Bay and Sitka (Table 7).

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Table 1. Southeast Alaska commercial herring catches from 1900 to 1990.

Year[b/]	Total Catch	Year	Total Catch	Year	Total Catch
1900	1,194	1935	58,155	1970	3,324
1901	1,250	1936	36,713	1971	4,207
1902	812	1937	50,334	1972	5,914
1903	1,494	1938	22,356	1973	6,268
1904	1,521	1939	20,028	1974	7,997
1905	1,309	1940	3,137	1975	8,098
1906	1,005	1941	6,230	1976	8,649
1907	1,382	1942	3,691	1977	6,053
1908	1,711	1943	6,235	1978	6,525
1909	1,075	1944	16,801	1979	9,204
1910	6,867	1945	24,126	1980	8,366
1911	12,057	1946	37,564	1981	8,630
1912	16,067	1947	41,829	1982	9,903
1913	13,496	1948	16,125	1983	9,081
1914	8,318	1949	14,279	1984	11,114
1915	6,964	1950	13,411	1985	9,792
1916	11,194	1951	10,652	1986	8,559
1917	12,445	1952	16,020	1987	15,267
1918	17,825	1953	12,435	1988	16,155
1919	10,962	1954	6,446	1989	8,209
1920	16,452	1955	11,368	1990	6,087
1921	6,012	1956	22,819		
1922	16,950	1957	24,745		
1923	21,240	1958	38,797		
1924	29,395	1959	49,866		
1925	57,782	1960	38,906		
1926	73,843	1961	24,709		
1927	45,310	1962	16,937		
1928	53,007	1963	15,606		
1929	78,749	1964	23,349		
1930	70,855	1965	12,159		
1931	44,857	1966	5,340		
1932	49,786	1967	3,025		
1933	61,588	1968	1,816		
1934	66,842	1969	3,682		

a/ Catches include fresh bait pound harvest.

b/ Catch includes total season, although referenced as only one year. Example: 1976 year includes 1976-77 seasonal catch from October 1, 1976 to September 30, 1977.

c/ 1989 and 1990 season catch includes herring equivalents for spawn on kelp harvest.

Table 2. Herring Hydroacoustic survey results 1986/87 through 1990/91.

1986-1987 Season

Area	Date	Run #	Area Sq. Meter X Million	Lbs. per Sq. Meter	Biomass in lbs X Million Computer Estimate	Visual Estimate	% >185 mm	Biomass >185mm Lbs X Million
Kah Shakes	04/02/87	1				1.0		
Meares Pass	12/11/86	1				4.5		
Meares Pass	01/07/87	1				5.5		
El Capitan	12/09/86	1				1.0		
Bocas de Finas	12/09/86	1	3.6	3.9	4.0	8.0	7.0	0.3
Bocas de Finas	12/09/86	2	3.6	3.4	12.1	11.0	7.0	0.9
Bocas de Finas	12/10/86	3	3.1	6.2	19.5	11.0	7.0	1.4
Bocas de Finas	12/10/86	4	3.1	8.7	27.3	11.0	7.0	1.9
Deer Island	11/19/86	1				2.0		
Anita Bay	11/18/86	1				5.5		
Port Camden	11/12/86	1				4.5		
Juneau	11/06/86	1				1.0		
Juneau	11/06/86	1				4.0		
Mab I.	04/21/87	1	0.6	27.3	15.9		no trawl	
Mab I.	04/21/87	2	0.8	22.4	17.4		no trawl	
Mab I.	04/21/87	3	0.8	49.9	38.7		no trawl	
Seymour Canal	05/03/87	1				7.0		
Tenakee	11/09/86	1	1.8	1.0	1.9		10.0	0.2
Tenakee	11/09/86	2	5.0	1.1	5.5		12.0	0.7
Tenakee	11/09/86	3	5.9	1.2	7.2		6.0	0.4
Tenakee	11/10/86	4	5.9	1.5	8.8		no trawl	
Tenakee	11/10/86	5	1.8	3.1	5.6		no trawl	
Tenakee	11/10/86	5	1.8	2.7	4.9			
Tenakee	11/11/86	6	5.0	1.0	5.2			
Tenakee	11/11/86	6	5.0	1.4	7.0			
Tenakee	12/15/86	1	5.3	6.8	35.7			
Tenakee	12/15/86	2	3.4	9.0	30.2	9.0		
Tenakee	12/16/86	3	7.9	1.4	11.0			
Tenakee	12/17/86	4	8.1	1.9	15.5			
Tenakee	12/17/86	5	8.4	1.4	11.7			
Tenakee	01/05/87	1	4.6	16.5	75.1	10.0	38.0	28.5
Tenakee	01/05/87	1	4.6	15.7	71.4		no trawl	
Tenakee	01/06/87	5	6.7	5.8	38.6		no trawl	
Tenakee	01/06/87	5	6.7	5.4	36.2		no trawl	
Tenakee	01/27/87	1	25.3	0.5	11.6	10.0	30.0	3.5
Tenakee	01/28/87	2	39.2	1.7	67.8		no trawl	
Tenakee	01/29/87	3	8.4	0.7	5.7		33.0	1.8
Lisianski	11/08/86	1				1.0		
Lisianski	11/08/86	1				1.0		
Lisianski	01/07/87	1				6.0		
Sitka Sound	03/19/87	1				32.0		

Table 2. (Page 2 of 5.)

1987-1988 Season

Area	Date	Run #	Area Sq. Meter X Million	Lbs. per Sq. Meter	Biomass in lbs X Million Computer Estimate	Visual Estimate	% >185 mm	Biomass >185mm Lbs X Million
Carroll Inlet	12/06/87	1				0.0		
George Inlet	12/06/87	1				0.0		
Tongass Narrows	12/06/87	1				1.0		
Anchor Pass	12/06/87	1				1.0		
Meares Pass	12/09/87	1	3.0	15.0	44.3	20.0	46.0	20.4
Meares Pass	12/09/87	2	2.7	15.4	42.1	20.0	46.0	19.4
Meares Pass	12/09/87	3	3.4	18.0	61.4	22.0	46.0	28.2
Meares Pass	01/14/88	1			no est.	15.0		
Meares Pass	01/14/88	2				15.0		
Meares Pass	01/08/88	3				15.0		
Tonowek Bay	12/08/87	1	8.6	1.7	14.8	10.0	63.0	9.3
Tonowek Bay	12/08/87	2	8.5	2.2	18.4		63.0	11.6
Anita Bay	12/15/87	1	4.9	2.1	10.4	10.0	0.0	
Port Camden	12/16/87	1	8.6	0.2	1.9	5.0	no trawl	
Port Camden	11/03/87	1	8.6	0.4	3.7	5.0	85.	3.1
Douglas I.	01/06/88	1				5.0		
Hood Bay	11/10/87	1				1.0		
Tenakee	11/05/87	1	7.2	5.1	36.7	18.0	49.0	17.9
Tenakee	11/05/87	2	7.2	5.7	41.3		49.0	20.3
Tenakee	11/05/87	3	7.2	6.0	43.5		49.0	21.3
Lisianski	11/08/87	2	1.1	1.8	1.8		26.0	0.5
Lisianski	11/08/87	1	1.1	6.3	6.7	4.0	26.0	1.7
Lisianski	11/07/87	1	1.8	24.7	44.6	15.0	16.0	7.1
Lisianski	11/09/87	2	1.5	44.6	64.7	15.0	16.0	10.4
Lisianski	11/09/87	3	1.1	66.5	73.7	13.0	16.0	11.8
Port Frederick	11/06/87	1				1.0	7.0	

Table 2. (Page 3 of 5.)

1988-1989 Season

Area	Date	Run #	Area Sq. Meter X Million	Lbs. per Sq. Meter	Biomass in lbs X Million Computer Estimate	Visual Estimate	% >185 mm	Biomass >185mm Lbs X Million
Meares Pass	12/14/88	1	2.8	1.7	4.7	15.0	89.0	4.2
Meares Pass	12/14/88	2	3.1	3.0	9.3		89.0	8.3
Meares Pass	12/14/88	3	3.1	1.6	5.1		89.0	4.5
Meares Pass	12/14/88	4	3.1	3.6	11.3		89.0	10.0
Meares Pass	12/14/88	5	3.1	2.2	6.8		89.0	6.1
Tonowek	12/13/88	1	4.3	10.5	44.7	10.0	56.0	25.1
Tonowek	12/13/88	2	4.3	8.3	35.4		56.0	19.8
Tonowek	12/13/88	3	4.5	8.0	35.6		56.0	19.9
Tonowek	12/13/88	4	4.5	6.3	28.0		56.0	15.7
Port Camden	11/02/88	1	0.7	0.5	0.4	1.0	no trawl	
Port Camden	11/02/88	2	12.0	0.4	0.4		no trawl	
Anita Bay	12/20/88	1	5.6	0.4	2.0		8.0	0.2
Anita Bay	12/20/88	2	5.6	1.5	8.3		8.0	0.7
Tenakee	11/04/88	1	2.7	1.3	3.5	10.0	61.0	2.1
Tenakee	11/05/88	1	4.5	0.9	4.0		61.0	2.5
Tenakee	11/06/88	2	4.1	1.0	4.1		61.0	2.5
Tenakee	11/06/88	1	4.3	0.5	2.1	5.0	79.0	1.6
Tenakee	11/06/88	2	4.7	1.5	6.8		79.0	5.4
Sitka Sound	03/12/88	1				35		
Sitka Sound	03/12/88	1				25		
Sitka Sound	03/12/88	1				20		
Lisianski	11/08/88	1	4.3	13.4	57.3	20.0	57.0	32.7
Lisianski	11/08/88	2	4.3	19.8	84.9		57.0	48.4
Lisianski	11/08/88	1	3.3	9.5	32.0		57.0	18.2

Table 2. (Page 4 of 5.)

1989-1990 Season

Area	Date	Run #	Area Sq. Meter X Million	Lbs. per Sq. Meter	Biomass in lbs X Million Computer Estimate	Visual Estimate	% >185 mm	Biomass >185mm Lbs X Million
Carroll Inlet	11/15/89	1				0.5		
George Inlet	11/15/89	1				0.0		
Tongass Narrows	11/06/89	1				1.0		
Anchor Pass	11/16/89	1				0.5		
Bocas de Finas	11/13/89	1	2.3	0.5	1.1	2.0	89.0	1.0
Bocas de Finas	11/13/89	2	2.2	0.4	.9	2.0	83.0	0.7
Bocas de Finas	11/13/89	3	2.2	0.3	.7	2.0	no trawl	
Bocas de Finas	11/13/89	4	2.2	0.6	1.4	2.0	no trawl	
Deer Island	11/16/89	1				1.0		
Port Camden	11/17/89	1				2.0		
Juneau	01/23/90	1			no est.	6.0	86.0	
Juneau	01/05/90	1			no est.	10.0	92.0	
Tenakee	01/10/90	1				3.0		
Tenakee	01/10/90	2				2.0		
Lisianski	11/10/89	1	4.6	0.9	4.1	6.0	1.0	0.0
Lisianski	11/10/89	2	3.9	0.4	1.6	4.0	1.0	0.0
Lisianski	11/10/89	3	4.2	0.1	.5	2.0	1.0	0.0
Lisianski	11/10/89	4	4.2	0.2	.9	2.0	1.0	0.0
Lisianski	01/07/90	1				3.0		
Lisianski	01/07/90	2				4.0		

Table 2. (Page 5 of 5.)

1990-1991 Season

Area	Date	Run #	Area Sq. Meter X Million	Lbs. per Sq. Meter	Biomass in lbs X Million Computer Estimate	Visual Estimate	% >185 mm	Biomass >185mm Lbs X Million
Kah Shakes	03/19/91	1				10 - 12		
Kah Shakes	03/20/91	1				3 - 5		
Kah Shakes	03/21/91	1				3 - 5		
Kah Shakes	03/27/91	1				13 - 17		
Kah Shakes	04/02/91	1				12 - 15		
Kah Shakes	04/04/91	1				>5		
Kah Shakes	04/06/91	1				3 - 5		
Kah Shakes	04/07/91	1				>2		
Carroll Inlet	12/02/91	1				0.5		
George Inlet	12/02/91	1				0.0		
Tongass Narrows	12/02/91	1				1.0		
Clover Pass	12/03/90	1				0.0		
Spacious Bay	12/03/90	1				0.0		
Bell Island	12/03/90	1				0.0		
Behm Narrows	12/03/90	1				0.0		
Anchor Pass	12/03/90	1				0.5		
Fitzgibbon Cove	12/03/90	1				0.0		
Deer Island	12/04/91	1				1.5		
Deer Island	12/04/91	2				2.0		
Anita Bay	12/05/90	1				3.0	0.0	
Anita Bay	12/05/90	2				2.0	0.0	
Tebenkof Bay	12/09/90	1				1.0		
Port Camden	12/08/90	1				1.5		
Port Camden	12/08/90	1				1.0	86.0	
Port Houghton	12/07/90	1				0.0		
Tenakee	12/10/90	1				2.5	10.0	
Sitka Sound	12/13/90	1				5.0		
Sitka Sound	12/14/90	1				0.0		
Lisisanski	12/11/90	1				25.0	2.0	
Lisisanski	12/11/90	1				0.0		

Table 3. Comparison of Hydroacoustical and Spawn Deposition Estimates 1986/87 through 1990/91.

	1987		1988		1989		1990		1991	
Area	Hyd	Spn	Hyd	Spn	Hyd	Spn	Hyd	Spn	Hyd	Spn
Kah Shakes	1.0v	16.8		12.3		6.6		12.8	17.0v	20.9
Craig	6.7v		33.1c	32.7	26.7c	39.6		36.7		35.6
Seymour	7.0v	10.0		6.4		6.2		5.7		4.2
Juneau	24.0c		5.0v	2.7			7.2v			
Tenakee	21.0c	13.0	19.8c	12.0	8.0c	10.7	2.5c	4.0	0.3v	0.4
Sitka	32.0v	91.2		117.3		54.4		45.5		46.9
Hoonah		2.0				8.4		4.7		5.4
Lisianski	3.5v		10.9c	11.9	33.1c	2.2	3.5c	2.0	0.5v	5.0

v = visual

c = computer assisted

Table 4. Summary of herring age, weight and length data from Southeast Alaska from 1986/87 through 1990/91.

AREA	II	III	IV	V	VI	VII	VIII+	%	N	% MALE
				AGE % CONTRIBUTION						
KAH SHAKES		1987 CAST NET SAMPLES PRE FISHERY								
Average % Contribution	0	42	14	12	23	5	1	97	462	69
Average Standard Length	0	168	184	198	206	219	225			
Average Weight	0	68	92	119	136	159	169			
		1987 CAST NET SAMPLES POST FISHERY								
Average % Contribution	0	54	17	10	13	3	1	98	524	80
Average Standard Length	0	166	178	196	203	213	222			
Average Weight	0	59	76	104	115	135	164			
		1987 COMMERCIAL GILL NET SAMPLES								
Average % Contribution	0	4	18	35	36	6	0	98	176	39
Average Standard Length	0	184	192	201	206	221				
Average Weight	0	94	104	121	134	165				
		1988 ACTIVE SPAWN CAST NET SAMPLES								
Average % Contribution	0	15	50	13	9	9	5	100	660	57
Average Standard Length	0	175	185	195	209	213	214			
Average Weight	0	78	96	111	136	149	153			
		1989 ACTIVE SPAWN CAST NET SAMPLES								
Average % Contribution	0	11	34	39	12	3	1	100	525	67
Average Standard Length	0	177	190	202	213	226	234			
Average Weight	0	71	88	109	129	151	176			
		1990 ACTIVE SPAWN CAST NET SAMPLES								
Average % Contribution	0	4	20	25	29	12	9	100	694	61
Average Standard Length	0	182	195	203	210	214	215			
Average Weight	0	84	99	116	127	138	140			
		1991 COMMERCIAL GILL NET SAMPLES								
Average % Contribution	0	4	6	30	29	20	11	101	511	
Average Standard Length	0	191	204	217	221	224	230			
Average Weight	0	112	102	128	141	151	148			
		1991 ACTIVE SPAWN CAST NET SAMPLES								
Average % Contribution	3	73	14	6	3	1	0	100	652	61
Average Standard Length	157	176	186	205	215	217	0			
Average Weight	41	59	69	92	112	110	0			

--Continued--

Table 4. (Page 2 of 8.)

AREA	II	III	IV	V	VI	VII	VIII+	%	N	% MALE
				AGE % CONTRIBUTION						
CAT ISLAND		1991 COMMERCIAL GILL NET SAMPLES								
Average % Contribution	0	0	1	28	33	28	10	100	413	53
Average Standard Length	0	211	216	222	224	228	233			
Average Weight	0	122	192	141	146	151	163			
		1991 CAST NET SAMPLES								
Average % Contribution	0	57	13	16	7	4	2	98	802	69
Average Standard Length	160	177	188	209	212	217	232			
Average Weight	45	61	76	105	105	126	152			
KETCHIKAN (WARD COVE)		1989 ACTIVE SPAWN CAST NET SAMPLES								
Average % Contribution	23	34	32	10	1	0	0	100	73	
Average Standard Length	112	154	181	199	205	0	0			
Average Weight	16	46	73	107	118	0	0			
		1991 ACTIVE SPAWN CAST NET SAMPLES								
Average % Contribution	5	75	10	8	1	1	0	100	95	64
Average Standard Length	152	167	197	201	237	216	0			
Average Weight	38	52	80	94	140	121	0			
CRAIG		1987-88 TRAWL SAMPLES								
Average % Contribution	0	16	6	9	7	5	4		291	46
Average Standard Length	0	163	180	193	206	210	222			
Average Weight	0	70	97	121	150	168	196			
		1987-88 TRAWL SAMPLES								
Average % Contribution	0	6	29	21	20	15	11	100	243	43
Average Standard Length	0	163	176	183	195	201	212			
Average Weight	0	69	94	106	128	143	170			
		1987-88 COMMERCIAL SEINE SAMPLES								
Average % Contribution	0	11	51	9	15	8	6		605	49
Average Standard Length	0	162	183	199	209	217	218			
Average Weight	0	62	96	126	150	173	178			
		1987-88 COMMERCIAL SEINE SAMPLES								
Average % Contribution	0	16	59	76	5	6	5	100	500	49
Average Standard Length	0	164	179	187	198	206	218			
Average Weight	0	65	96	104	126	139	171			
		1988 ACTIVE SPAWN CAST NET SAMPLES								
Average % Contribution	0	16	67	6	5	3	2	100	864	67
Average Standard Length	0	172	188	195	209	218	229			
Average Weight	0	66	91	102	127	147	168			

--Continued--

Table 4. (Page 3 of 8.)

AREA	II	III	IV	V	VI	VII	VIII+	%	N	% MALE
				AGE % CONTRIBUTION						
CRAIG (Cont.)		1989 ACTIVE SPAWN CAST NET SAMPLES								
Average % Contribution	0	3	28	59	7	2	1	100	1308	61
Average Standard Length	0	172	190	202	213	225	225			
Average Weight	0	61	86	103	123	137	152			
		1989-90 TRAWL SAMPLES								
Average % Contribution	1	4	2	37	34	6	5	100	591	49
Average Standard Length	161	180	188	199	206	210	217			
Average Weight	51	75	88	105	117	125	140			
		1989-90 COMMERCIAL SEINE SAMPLES								
Average % Contribution	0	3	16	34	33	8	5	100	481	48
Average Standard Length	152	179	190	202	209	212	222			
Average Weight	41	72	87	105	118	125	147			
		1989-90 COMMERCIAL SEINE SAMPLES								
Average % Contribution	0	0	4	27	51	7	10	100	330	49
Average Standard Length	0	196	197	207	215	222	234			
Average Weight	0	100	99	115	132	148	175			
		1990 ACTIVE SPAWN CAST NET SAMPLES								
Average % Contribution	0	2	12	34	40	9	3	100	942	60
Average Standard Length	157	170	189	200	206	216	226			
Average Weight	52	68	92	110	121	140	165			
* 184 additional fish sampled										
		1990-91 COMMERCIAL SEINE SAMPLES								
Average % Contribution	1	37	7	9	20	24	2	100	464	56
Average Standard Length	173	182	190	207	214	218	227			
Average Weight	60	76	84	113	128	140	151			
		1991 ACTIVE SPAWN CAST NET SAMPLES								
Average % Contribution	1	43	6	7	21	17	5	100	534	60
Average Standard Length	163	179	185	205	215	218	226			
Average Weight	51	66	75	102	117	129	145			
VIXEN INLET (ERNEST SOUND)		1988 ACTIVE SPAWN CAST NET SAMPLES								
Average % Contribution	31	32	25	90	2	1	0	100	102	66
Average Standard Length	143	163	174	200	207	218				
Average Weight	39	55	63	94	98	122				
ANITA BAY		1988 TRAWL SAMPLES								
Average % Contribution	4	52	35	4	3	2	0	100	180	44
Average Standard Length	146	160	167	181	194	197	0			
Average Weight	41	51	61	72	91	98	0			

--Continued--

Table 4. (Page 4 of 8.)

AREA	II	III	IV	V	VI	VII	VIII+	%	N	% MALE
				AGE % CONTRIBUTION						
ANITA BAY (Cont.		1990-91 TRAWL SAMPLES								
Average % Contribution	51	44	4	1	0	0	0	100	104	21
Average Standard Length	140	161	182	189	0	0	0			
Average Weight	30	47	76	74	0	0	0			
PORT CAMDEN		1987-88 TRAWL SAMPLES								
Average % Contribution	0	5	25	9	28	23	10	100	104	60
Average Standard Length	0	160	181	186	200	205	219			
Average Weight	0	70	107	117	144	153	198			
SEYMOUR CANAL		1987 ACTIVE SPAWN CAST NET SAMPLES								
Average % Contribution	0	6	13	28	31	15	8	100	934	60
Average Standard Length	0	165	168	183	195	206	213			
Average Weight	0	67	75	94	116	138	150			
		1988 ACTIVE SPAWN CAST NET SAMPLES								
Average % Contribution	0	2	16	14	27	25	16	100	608	58
Average Standard Length	0	164	193	198	210	212	222			
Average Weight	0	57	94	101	118	126	144			
		1989 ACTIVE SPAWN CAST NET SAMPLES								
Average % Contribution	20	20	24	20	15	9	8	100	429	61
Average Standard Length	165	182	187	201	210	219	227			
Average Weight	40	57	80	103	120	140	142			
		1990 ACTIVE SPAWN CAST NET SAMPLES								
Average % Contribution	0	6	22	9	18	19	23	97	730	61
Average Standard Length	0	166	178	192	200	204	209			
Average Weight	0	58	69	91	101	106	120			
		1991 ACTIVE SPAWN CAST NET SAMPLES								
Average % Contribution	3	51	9	11	4	6	16	100	564	52
Average Standard Length	143	164	175	189	202	209	217			
Average Weight	33	49	62	80	98	112	127			
JUNEAU		1988 PRESPAWN & ACTIVE SPAWN CAST NET SAMPLES								
Average % Contribution	0	4	45	13	15	15	8	100	485	47
Average Standard Length	0	171	187	199	208	217	223			
Average Weight	0	59	79	89	104	115	131			
		1989 ACTIVE SPAWN CAST NET SAMPLES								
Average % Contribution	1	6	10	46	19	15	4	100	129	49
Average Standard Length	163	174	188	195	204	217	204			
Average Weight	50	63	82	93	102	126	104			

--Continued--

Table 4. (Page 5 of 8.)

AREA	II	III	IV	AGE % CONTRIBUTION V	VI	VII	VIII+	%	N	% MALE
TENAKEE		1987 PURSE SEINE ACTIVE SPAWN SAMPLES								
Average % Contribution	0	30	13	15	28	10	3	99	417	55
Average Standard Length	0	166	180	194	203	213	221			
Average Weight	0	68	89	115	135	160	178			
		1987-88 TRAWL SAMPLES								
Average % Contribution	0	4	65	10	12	6	3	100	582	49
Average Standard Length	0	169	171	184	198	202	208			
Average Weight	0	76	82	104	130	142	148			
		1988 ACTIVE SPAWN CAST NET SAMPLES								
Average % Contribution	0	1	41	18	12	16	12	100	262	66
Average Standard Length	0	179	183	197	212	215	223			
Average Weight	0	64	69	84	109	113	129			
		1988-89 TRAWL SAMPLES								
Average % Contribution	1	2	5	63	12	9	8	100	317	60
Average Standard Length	167	175	189	193	202	214	224			
Average Weight	62	69	90	96	114	128	163			
		1989 ACTIVE SPAWN CAST NET SAMPLES								
Average % Contribution	5	9	12	51	15	7	2	100	330	63
Average Standard Length	153	170	186	196	207	213	218			
Average Weight	45	63	82	97	115	126	132			
		1989-90 COMMERCIAL SEINE SAMPLES								
Average % Contribution	1	3	5	18	48	16	10	100	425	47
Average Standard Length	148	175	194	208	211	218	224			
Average Weight	35	70	9436	123	129	143	154			
		1990 ACTIVE SPAWN CAST NET SAMPLES								
Average % Contribution	0	10	11	20	37	13	10	101	224	52
Average Standard Length	155	182	190	210	213	220	230			
Average Weight	38	67	81	108	111	126	142			
SITKA		1987 ACTIVE SPAWN CAST NET SAMPLES								
Average % Contribution	0	53	17	4	10	14	1	100	669	60
Average Standard Length	0	169	186	198	210	217	223			
Average Weight	0	67	88	108	134	152	177			
		1988 ACTIVE SPAWN CAST NET SAMPLES								
Average % Contribution	0	2	85	6	3	3	1	100	721	60
Average Standard Length	0	175	187	199	217	225	229			
Average Weight	0	65	77	99	122	140	163			

--Continued--

Table 4. (Page 6 of 8.)

AREA	II	III	IV	V	VI	VII	VIII+	%	N	% MALE
				AGE % CONTRIBUTION						
SITKA (Cont.)		1989-90 TRAWL SAMPLES								
Average % Contribution	0	1	30	66	2	1	0	100	416	50
Average Standard Length	0	177	181	188	203	223	232			
Average Weight	0	68	70	81	89	122	162			
		1989-90 TEST SEINE SAMPLES								
Average % Contribution	0	3	24	66	3	2	0	100	350	55
Average Standard Length	0	167	182	195	212	228	237			
Average Weight	0	54	67	87	114	129	160			
		1989 ACTIVE SPAWN CAST NET SAMPLES								
Average % Contribution	0	1	19	75	2	1	1	99	1517	64
Average Standard Length	0	176	188	195	206	222	226			
Average Weight	0	65	77	88	103	131	128			
		1990 COMMERCIAL SEINE SAMPLES								
Average % Contribution	0	0	1	15	76	6	2	100	933	64
Average Standard Length	0	187	193	203	207	214	231			
Average Weight	0	74	86	105	113	127	158			
		1990 ACTIVE SPAWN CAST NET SAMPLES								
Average % Contribution	0	2	1	15	71	9	3	100	1085	56
Average Standard Length	0	178	186	203	206	209	222			
Average Weight	0	68	76	102	108	115	139			
		1990-91 TRAWL SAMPLES								
Average % Contribution	2	93	1	0	1	3	0	100	235	47
Average Standard Length	164	172	173	185	213	208	0			
Average Weight	50	59	59	74	131	120	0			
		1991 TEST SEINE SAMPLES								
Average % Contribution	0	73	3	1	3	20	1	100	643	54
Average Standard Length	0	177	187	196	222	219	226			
Average Weight	0	58	72	101	147	122	137			
		1991 ACTIVE SPAWN CAST NET SAMPLES								
Average % Contribution	1	75	5	1	4	15	1	100	777	62
Average Standard Length	178	176	179	191	217	218	225			
Average Weight	54	58	61	70	116	121	128			
HOONAH SOUND		1989 ACTIVE SPAWN CAST NET SAMPLES								
Average % Contribution	0	0	13	72	11	4	0	100	70	58
Average Standard Length	0	0	192	198	217	221	0			
Average Weight	0	0	92	104	125	139	0			

--Continued--

Table 4. (Page 7 of 8.)

AREA	II	III	IV	V	VI	VII	VIII+	%	N	% MALE
				AGE % CONTRIBUTION						
HOONAH SOUND (Cont.)		1991 ACTIVE SPAWN CAST NET SAMPLES								
Average % Contribution	2	44	8	4	15	22	5	100	553	57
Average Standard Length	158	178	189	210	218	219	227			
Average Weight	42	61	77	101	117	129	138			
SLOCUM ARM		1988 COMMERCIAL BAIT HARVEST								
Average % Contribution	0	5	83	7	2	2	1	100	217	54
Average Standard Length	0	159	169	172	179	189	202			
Average Weight	0	60	69	75	88	97	121			
LISIANSKI		1987-88 TRAWL SAMPLES								
Average % Contribution	0	6	87	5	2	0	0	100	516	51
Average Standard Length	0	168	168	170	190	0	0			
Average Weight	0	76	76	78	119	0	0			
		1987-88 COMMERCIAL SEINE SAMPLES								
Average % Contribution	0	1	96	3	0	0	0	100	148	50
Average Standard Length	0	166	172	178	0	0	0			
Average Weight	0	63	71	78	0	0	0			
		1988 ACTIVE SPAWN CAST NET SAMPLES								
Average % Contribution	0	8	84	7	1	1	0	100	647	69
Average Standard Length	0	167	178	194	214	209	199			
Average Weight	0	52	62	83	120	107	85			
		1989-90 TRAWL SAMPLES								
Average % Contribution	23	12	3	14	44	4	0	100	838	51
Average Standard Length	134	172	184	200	200	206	214			
Average Weight	7	18	15	14	16	19	4			
* Two age 1 herring in samples										
		1989-90 COMMERCIAL SEINE SAMPLES								
Average % Contribution	0	5	4	22	65	2	2	100	100	46
Average Standard Length	0	181	190	200	204	219	206			
Average Weight	0	7	11	12	19	4	2			
		1989 ACTIVE SPAWN CAST NET SAMPLES								
Average % Contribution	0	2	27	67	3	0	0	99	220	80
Average Standard Length	0	169	180	182	193	0	0			
Average Weight	0	80	85	79	43	0	0			
		1990-91 TRAWL SAMPLES								
Average % Contribution	3	94	1	0	1	1	0	100	425	39
Average Standard Length	161	166	181	187	206	198	0			
Average Weight	47	51	70	76	110	88	0			

--Continued--

Table 4. (Page 8 of 8.)

AREA	II	III	IV	V	VI	VII	VIII+	%	N	% MALE
	AGE % CONTRIBUTION									
LISIANSKI (Cont.)		1991 ACTIVE SPAWN CAST NET								
Average % Contribution	2	90	3	0	1	3	0	100	427	75
Average Standard Length	158	168	181	210	205	202	0			
Average Weight	38	46	56	110	86	87	0			

Total N = 31173

Table 5. Summary of Herring spawn deposition surveys 1987 to 1991.

Area	Total # Transects	Transect Interval Miles	Avg Meter Width Eggs	Avg 1000s Eggs per Sample	Total Miles Spawn	Millions Pounds Escape	Millions Pounds per Mile	Millions Pounds Threshold	Percent Harvest Rate	Quota 1988 Tons	Catch 1987 Tons
					1987 Summary						
Kah Shakes	17	0.5	113.5	35.9	10.0	16.8	1.7	10.0	11.4	953	1470
Seymour	22	0.5	34.0	64.4	11.3	10.0	0.9	6.0	11.1	534	302
Tenakee	10	1.0	64.0	49.5	10.0	13.0	1.3	6.0	12.4	1450	1275
Sitka	81	1.0	46.0	51.6	94.0	91.2	1.0	15.0	20.0	9200	4216
Hoonah Snd	6	0.5	40.8	32.6	3.8	2.0	0.5	2.0	0.0	0	0
Total	136				129.1	133.0				12137	7263
Average	27	0.7	59.7	46.8	25.8	26.6	1.1	7.8	11.0	2427	1453
					1988 Summary						
Kah Shakes	23	0.3	87.6	50.6	6.8	12.3	1.8	10.0	10.5	647	1145
Craig	13	0.5	60.0	49.0	27.0	32.7	1.2	10.0	14.5	2335	2014
Seymour	37	0.5	26.6	36.0	16.4	6.4	0.4	6.0	10.2	329	586
Juneau	13	0.5	20.4	47.4	7.3	2.7	0.4	10.0	0.0	0	0
Tenakee	17	0.5	30.3	31.7	12.0	12.0	1.0	6.0	12.0	720	1577
Sitka	61	1.0	32.2	85.2	104.0	117.3	1.1	15.0	20.0	11725	9390
Lisianski	17	0.5	20.8	118.4	11.8	11.9	1.0	5.0	12.8	739	280
Total	181				185.2	195.3				16495	14992
Average	26	0.5	39.7	59.8	26.5	27.9	1.0	8.9	11.4	2356	2142

Table 5. (Page 2 of 3.)

Area	Total # Transects	Transect Interval Miles	Avg Meter Width Eggs	Avg 1000s Eggs per Sample	Total Miles Spawn	Millions Pounds Escape	Millions Pounds per Mile	Millions Pounds Threshold	Percent Harvest Rate	Quota 1988 Tons	Catch 1987 Tons
					1989 Summary						
Kah Shakes #1	17	0.5	66.1	34.8	6.5	6.2	1.0	10.0			
Kah Shakes #2	5	0.5	23.0	18.4	2.5	0.4	0.2	10.0			
K. S. Summary	22				9.0	6.6	0.7	10.0	0.0	0	595
Craig	29	1.0	43.1	70.3	31.7	39.6	1.3	10.0	15.9	3152	1691
								Quota set by Board of Fisheries			
Farragut	9	0.5	17.8	8.7	4.5	0.3	0.1	100 tons for fresh bait pounds			0
Seymour	38	0.3	31.9	60.8	7.8	6.2	0.8	6.0	10.1	312	547
Tenakee	26	0.5	39.7	60.4	10.9	10.7	1.0	6.0	11.6	620	655
Sitka	51	1.0	33.0	60.7	65.5	54.4	0.8	15.0	15.3	4146	11831
Hoonah Snd	16	1.0	27.5	43.6	17.0	8.4	0.5	4.0	0.0	0	0
Lisianski	13	0.5	29.6	27.1	6.5	2.2	0.3	5.0	0.0	0	770
Total	191				146.4	126.2				8230	15319
Average	27	0.7	35.3	44.7	20.9	18.0	0.7	6.4	8.8	1372	2188
					1990 Summary						
Kah Shakes #1	6	0.3	36.6	20.0	1.5	0.5	0.3				
Kah Shakes #2	16	0.5	70.5	47.4	9.0	12.4	1.4				
K. S. Summary	22				10.5	12.8	1.2	10.0	10.6	679	0
Craig	28	1.0	45.9	64.7	30.0	36.7	1.2	10.0	15.3	2814	3221
Seymour	20	0.3	58.5	48.0	4.9	5.7	1.2	6.0	0.0	361	359
Tenakee	16	0.3	65.0	36.6	4.1	4.0	1.0	6.0	0.0	0	595
Sitka	34	1.0	49.3	57.3	39.0	45.5	1.2	15.0	14.1	3200	3804
Hoonah Snd *	16	0.5	25.0	47.4	10.0	4.7	0.5	4.0	NA	12	11.8
Lisianski	11	0.5	24.1	38.2	5.4	2.0	0.4	5.0	0.0	250	27
Total	147				103.9	111.4				7316	8018
Average	21	0.5	46.9	45.0	14.8	15.9	0.9	8.0	6.6	1045	1145

Table 5. (Page 3 of 3.)

Area	Total # Transects	Transect Interval Miles	Avg Meter Width Eggs	Avg 1000s Eggs per Sample	Total Miles Spawn	Millions Pounds Escape	Millions Pounds per Mile	Millions Pounds Threshold	Percent Harvest Rate	Quota 1988 Tons	Catch 1987 Tons
					1991 Summary						
Cat Island	25.0	0.5	85.0	47.3	11.2	18.5	1.7				380
Kah Shakes	11.0	0.4	67.7	23.0	3.7	2.4	0.6				280
Combined Areas					14.9	20.9	1.4	12.0	11.5	1200	660
Craig **	23.0	1.0	61.5	63.7	22.0	35.6	1.6	10.0	15.2	2684	3272
Seymour	24.0	0.3	30.2	61.2	5.5	4.2	0.8	6.0	0.0	0	0
Hobart Bay/ *** P. Houghton	20.0	0.5			8.8	4	0.5	4.0	10.0	200	0
Tenakee	14.0	0.3	36.3	6.6	4.3	0.4	0.1	6.0	0.0	0	0
Sitka	43.0	1.0	42.7	60.0	44.5	46.9	1.1	15.0	14.3	3356	1908
Hoonah Snd *	17.0	0.5	55.0	27.2	8.7	5.4	0.6	2.0	NA	12	13.5
Lisianski	18.0	0.5	26.4	46.9	9.8	5.0	0.5	5.0	10.0	250	0
Total	195.0				118.5	118.4				7690	5854
Average	21.7	0.5	50.6	42.0	14.8	14.8	0.8		7.6	961	732

Hoonah Snd *, catch is tons of spawn on kelp. The quota for Hoonah Sound was established as 150 tons of herring.
Craig **, 85% of quota or 2281 tons allocated to the winter bait fishery.
15% or 403 tons allocated to the spawn on kelp fishery for 1992.
Hobart Bay/P. Houghton ***, Biomass is a visual estimate based on partial aerial and spawn deposition surveys.

Table 6. Herring spawning threshold levels for major herring stocks in Southeast Alaska and Yakutat.

Area	Threshold Level Current Designation	(Millions of Pounds)
Hoonah Sound	Spawn-on-Kelp	2
Yakutat Bay	Winter Food and Bait	2
Deer Island	Winter Food and Bait	5
Anita Bay	Winter Food and Bait	5
Port Camden	Winter Food and Bait	5
Lisianski Inlet	Winter Food and Bait	5
Seymour Canal	Sac Roe Gill Net	6
Tenakee Inlet	Winter Food and Bait	6
Tongass Narrows George and Carroll Inlets	Winter Food and Bait	7
Meares Passage/Boca de Finas	Winter Food and Bait	10
Craig	Spawn on Kelp (15% of bait quota)	12.7
Kah Shakes and Cat Island	Sac Roe Gill Net	12
Lynn Canal	Sac Roe Seine	10
Sitka Sound	Sac Roe Seine	15
Other stocks not included above	Winter Food and Bait	4

Table 7. Summary of herring harvests during the 1986/87 through 1990/91 season.

Area	District	Type	Estimate Tons for Quota	Tons Quota	Tons Harvest Rate %	Tons Harvest	Opening Date	Closing Date
1986-87 Season								
Craig Area	3/4	Winter Bait	9700	1050	10.8	1231	01-10-87	01-10-87
Tenakee	12	Winter Bait	6500	800	12.3	1275	01-10-87	01-10-87
Farragut	10	Bait Pound	NA	100	NA	3		
Sitka	13	Bait Pound	NA	100	NA	62		
			Total Bait			2571		
Kah Shakes	1	GN Sac Roe	11400	1200	10.5	1470	03-26-87	03-27-87
Seymour	11	GN Sac Roe	3950	400	10.1	302	05-01-87	05-06-87
Sitka	13	Seine Sac Roe	22750	3600	15.8	4216	03-31-87	03-31-87
			Total Sac Roe			5988		
1987-88 Season								
Craig Area	3/4	Winter Bait	16550	2150	13.0	2014	01-04-88	01-14-88
Tenakee	12	Winter Bait	9900	1450	14.6	1577	01-04-88	01-04-88
Lisianski	13	Winter Bait	2500	250	10.0	280	01-04-88	01-04-88
Slocum Arm	13	Winter Bait	2500	250	10.0	258	01-04-88	01-09-88
Sitka	13	Bait Pound	NA	100	NA	17		
			Total Bait			4146		
Kah Shakes	1	GN Sac Roe	8400	953	11.3	1145	03-25-88	03-25-88
Seymour	11	GN Sac Roe	4800	534	11.1	586	04-26-88	05-01-88
Sitka	13	Seine Sac Roe	46000	9200	20.0	9390	04-04-88	04-14-88
			Total Sac Roe			11121		
1988-89 Season								
Craig Area	3/4	Winter Bait	13300	1810	13.6	1691	01-09-89	01-14-89
Tenakee	12	Winter Bait	6000	720	12.0	655	01-09-89	01-09-89
Lisianski	13	Winter Bait	5950	740	12.4	770	01-09-89	01-12-89
Sitka	13	Bait Pound	NA		NA	66		
			Total Bait			3182		
Kah Shakes	1	GN Sac Roe	6150	647	10.5	595	03-20-89	03-20-89
Seymour	11	GN Sac Roe	3250	332	10.2	547	04-28-89	04-28-89
Sitka	13	Seine Sac Roe	58650	11700	20.0	11831	03-31-89	04-08-89
			Total Sac Roe			12973		
1989-90 Season								
Craig Area	3/4	Winter Bait	19800	3150	15.9	3221	01-14-90	01-29-90
Tenakee	12	Winter Bait	5350	650	12.1	595	01-14-90	01-15-90
Lisianski	13	Winter Bait	2500	250	10.0	27	01-14-90	01-30-90
Sitka	13	Bait Pound	NA	100	NA	38		
			Total Bait			3881		
Seymour	11	GN Sac Roe	3100	312	10.1	359	04-28-90	04-30-90
Sitka	13	Seine Sac Roe	27000	4146	15.4	3804	04-05-90	04-06-90
Seymour	11	GN Test Fish	NA			15		
			Total Sac Roe			4178		

--Continued--

Table 7. (Page 2 of 2.)

Area	District	Type	Estimate Tons for Quota	Tons Quota	Tons Harvest Rate %	Tons Harvest	Opening Date	Closing Date
Hoonah Snd.	13	Spawn on Kelp	NA	150		11.8 tons spawn on kelp		
		Total Spawn on Kelp				11.8		
<u>1990-91 Season</u>								
Craig Area	3/4	Winter Bait	18550	2814	15.2	3272	01-14-91	01-24-91
Farragut	10	Bait Pound	NA	100		16		
Sitka	13	Bait Pound	NA	100		65		
		Total Bait				3353		
Kah Shakes	1	GN Sac Roe	6400	679	10.6	660	04-08-91	04-11-91
Sitka	13	Seine Sac Roe	22750	3200	14.1	1908	04-10-91	04-13-91
Seymour	10	GN Test Fish	NA			16		
		Total Sac Roe				2584		
Hoonah Snd.	13	Spawn on Kelp	NA	150		13.5 tons spawn on kelp		

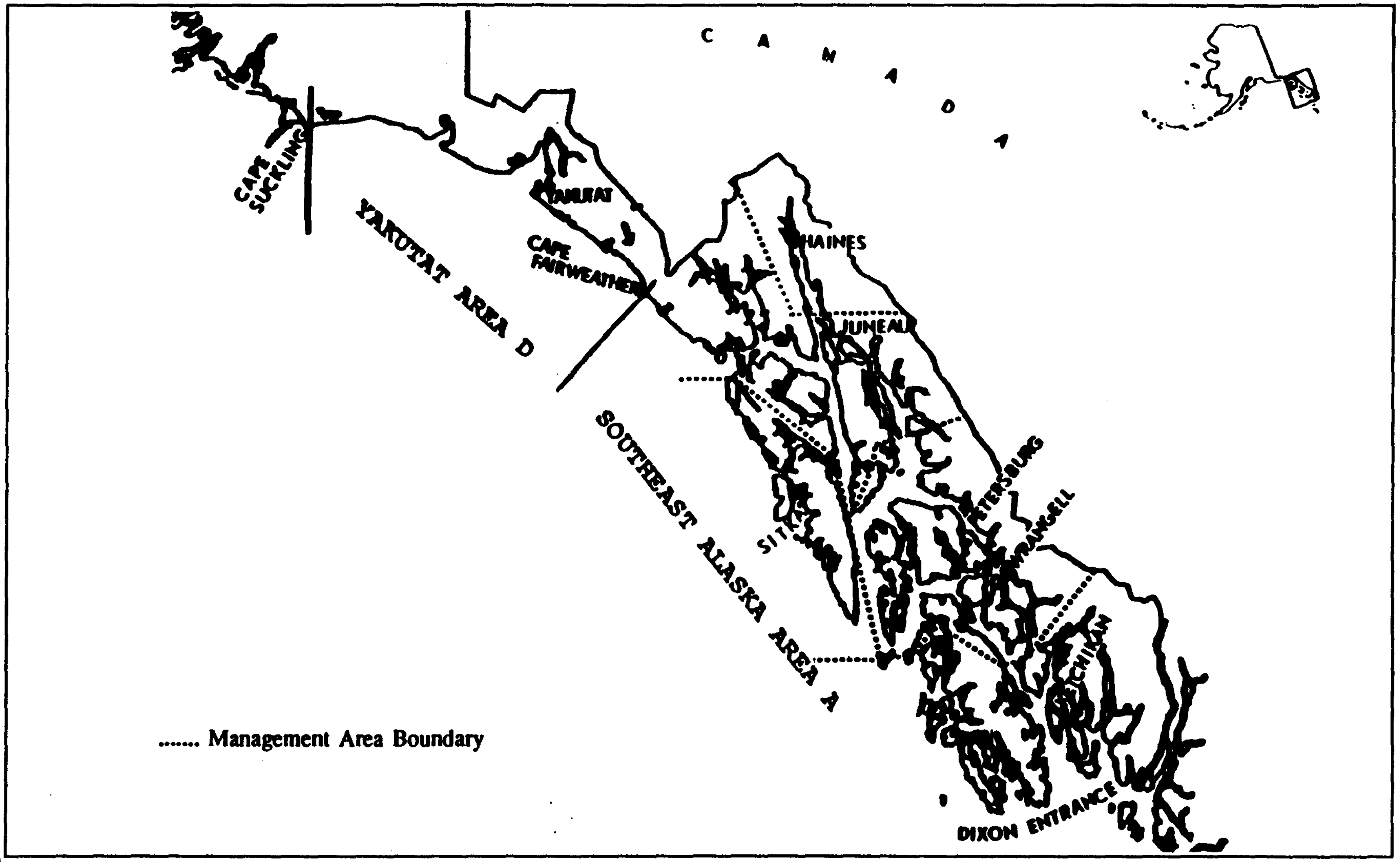


Figure 1. Southeast Alaska Region (Region 1) herring registration areas (Southeast Alaska Area A and Yakutat Area D) and management area boundaries.

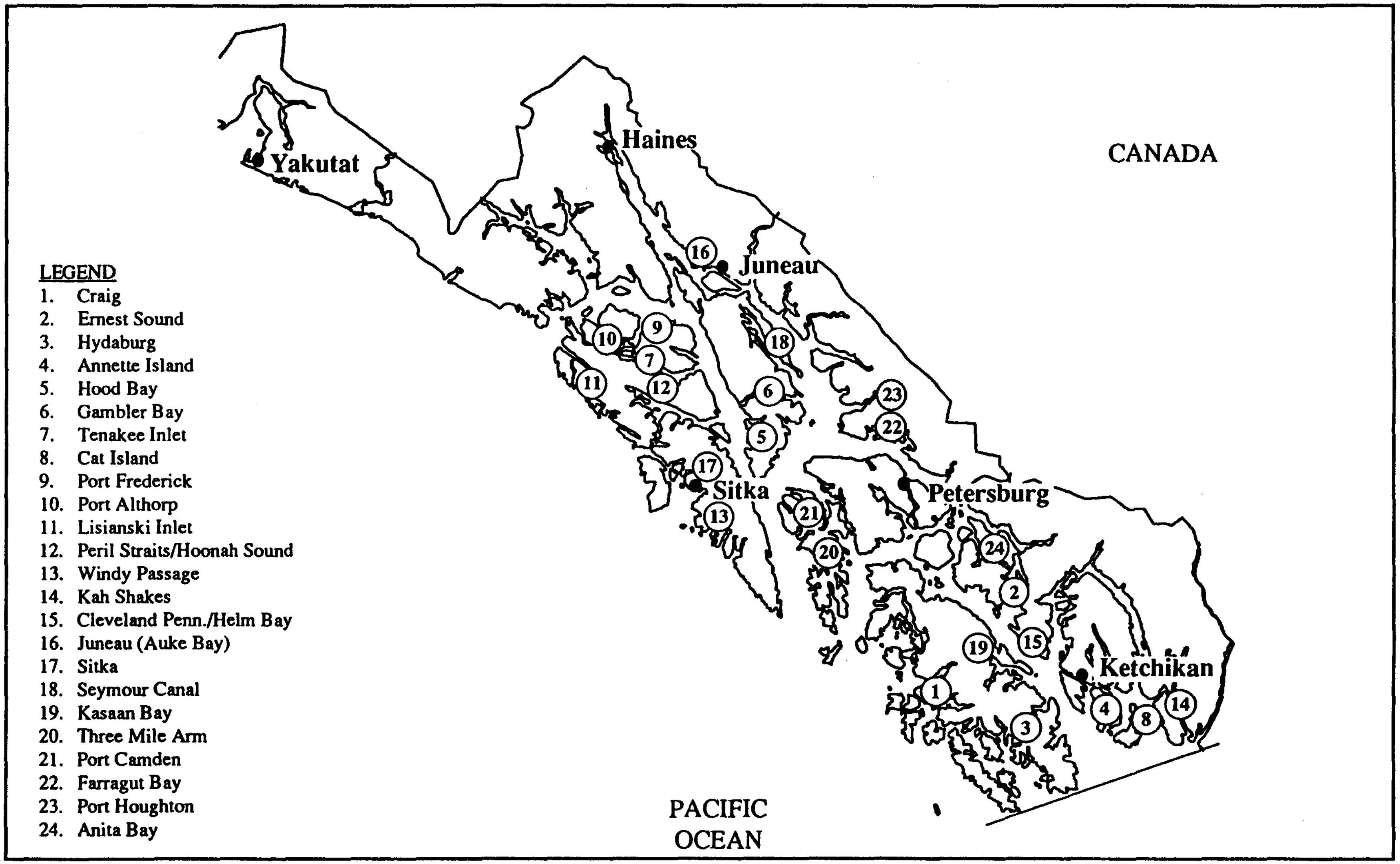


Figure 2. Southeast Alaska herring project study areas 1986/87 through 1990/91.

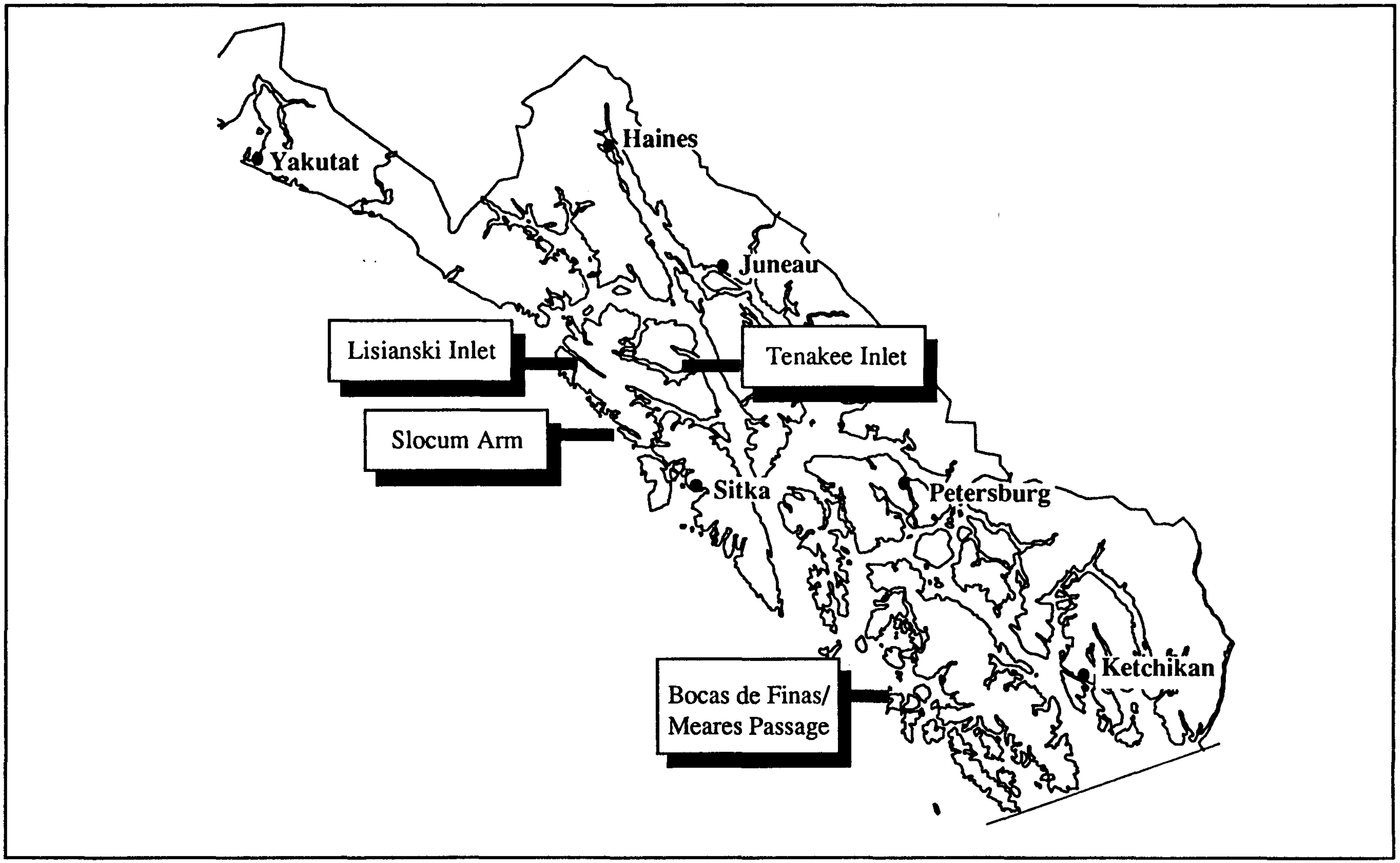


Figure 3. Southeast Alaska herring food and bait fishing area, 1986/87 through 1990/91.

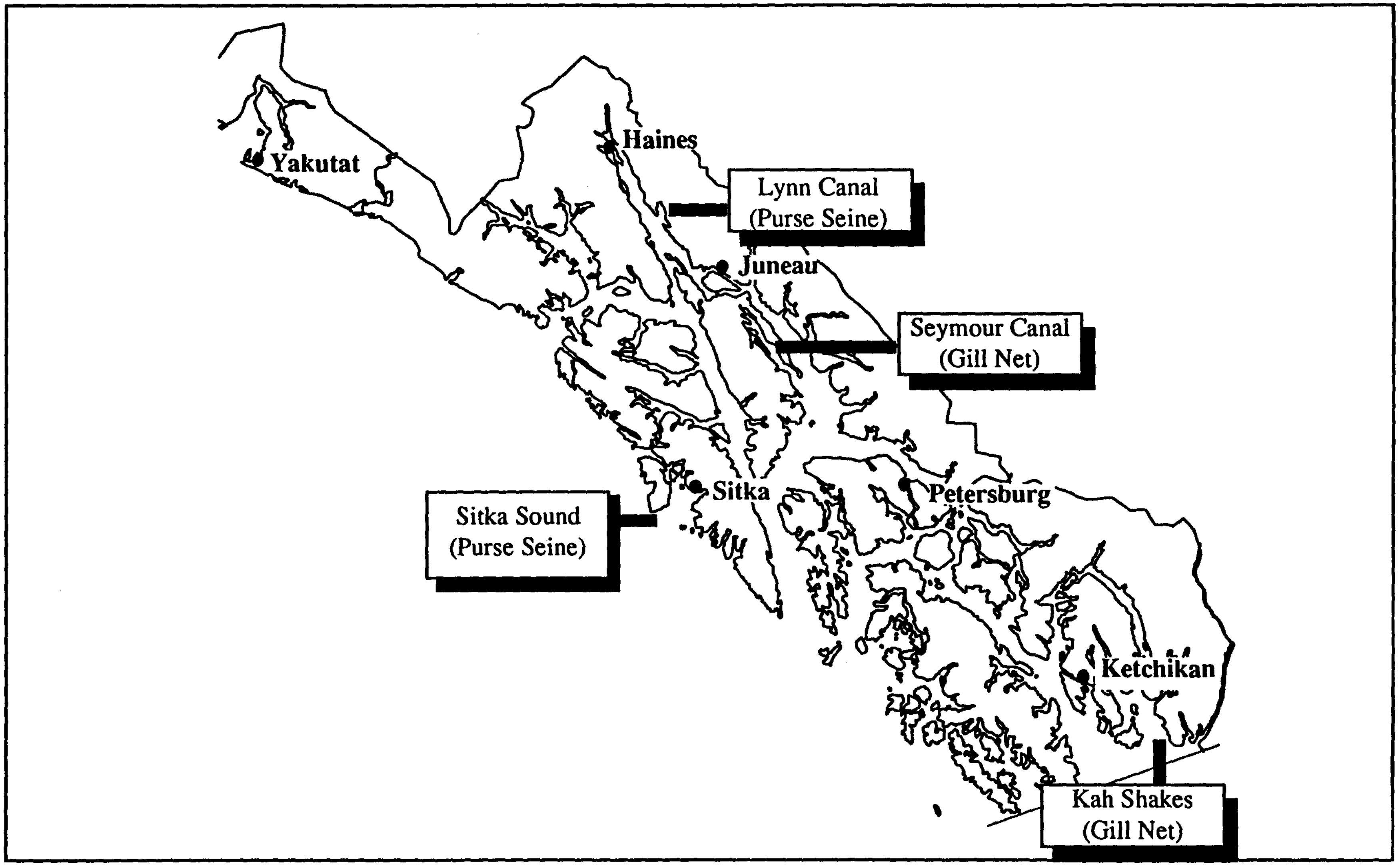


Figure 4. Southeast Alaska sac roe fishing areas.

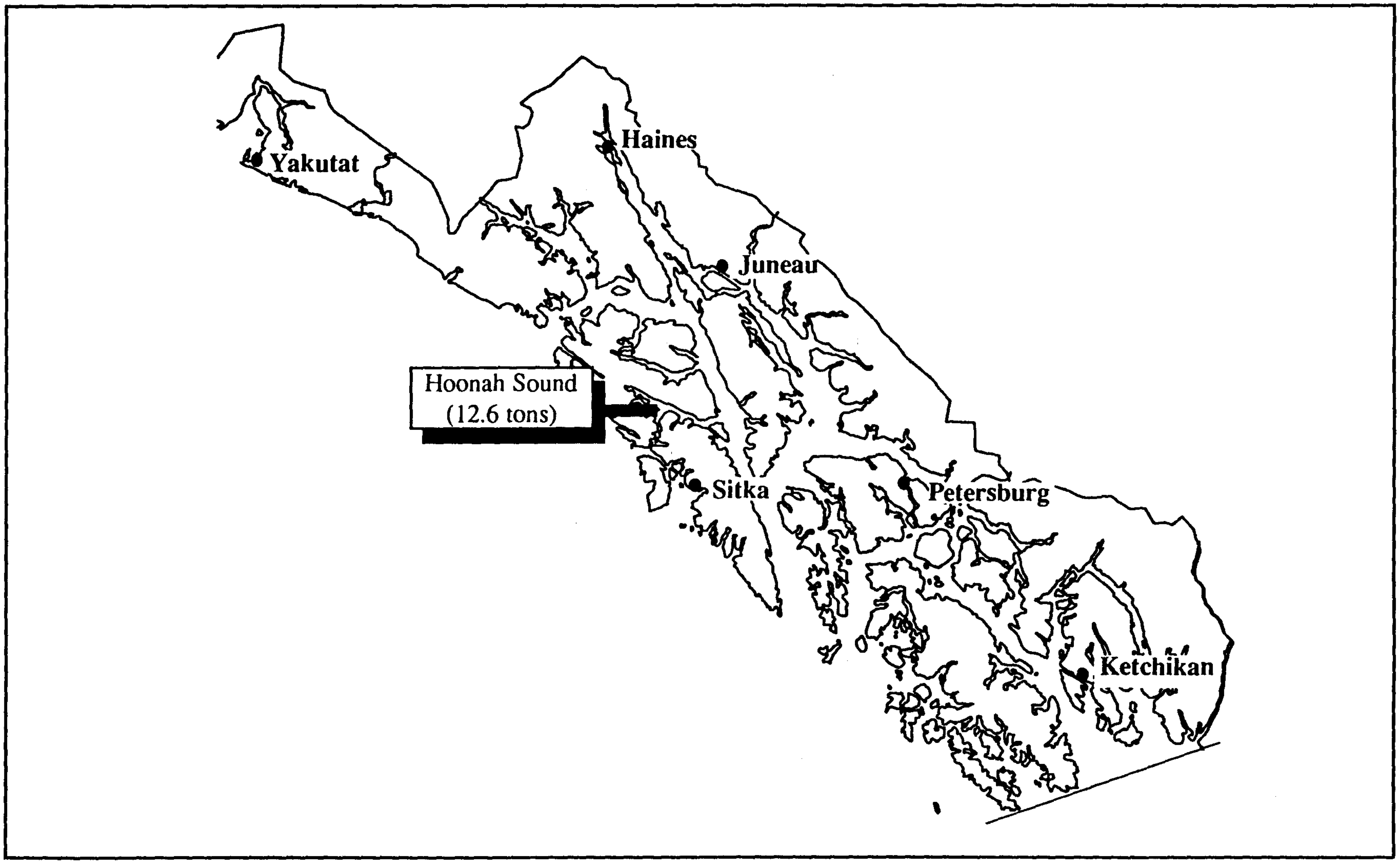


Figure 5. Southeast Alaska spawn on kelp pound fishing area, quota by regulation.

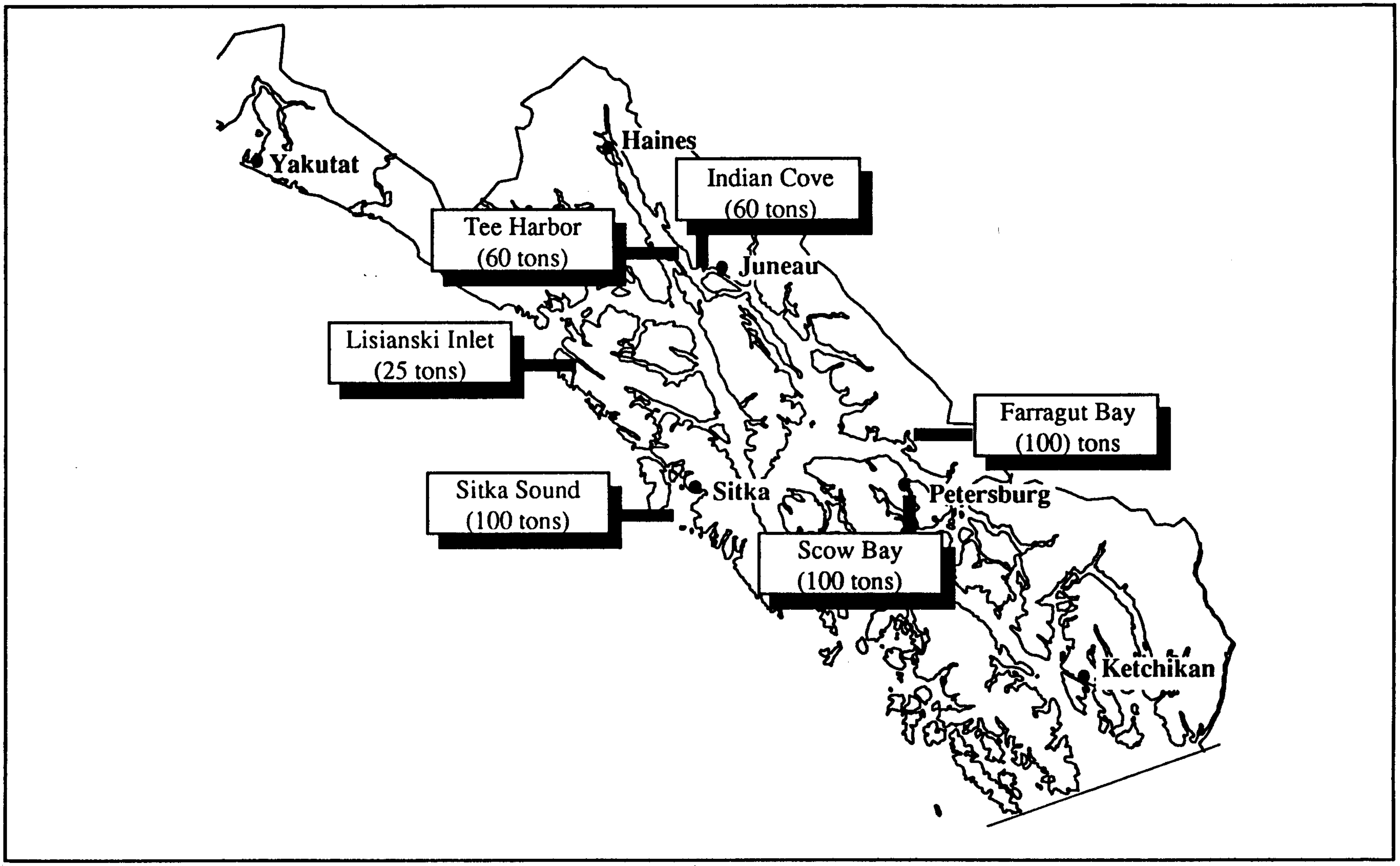


Figure 6. Southeast Alaska fresh bait pound fishing areas, quotas by regulation.

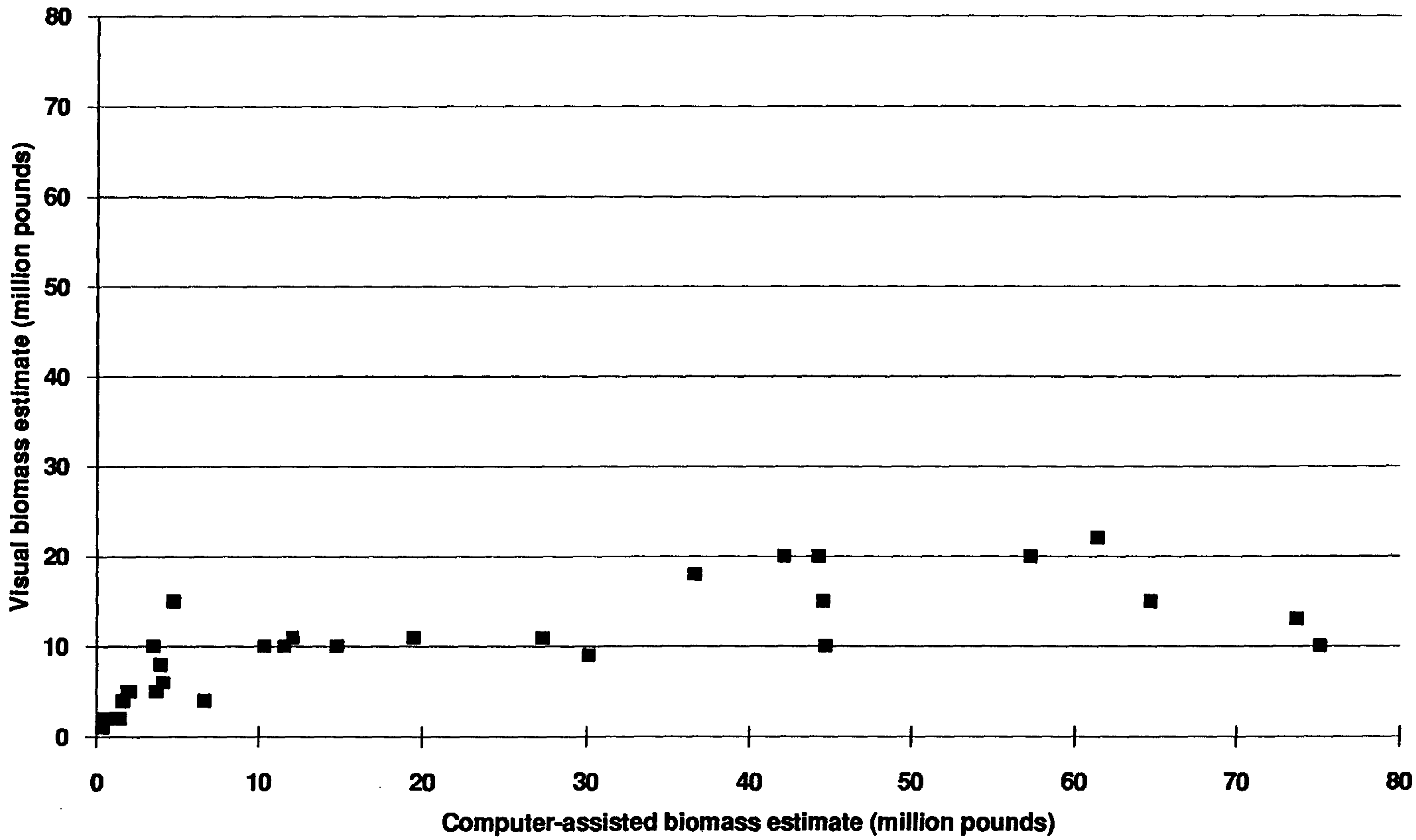


Figure 7. Relationship between visual and computer-assisted hydroacoustic survey estimates, 1986/87 through 1990/91 seasons.

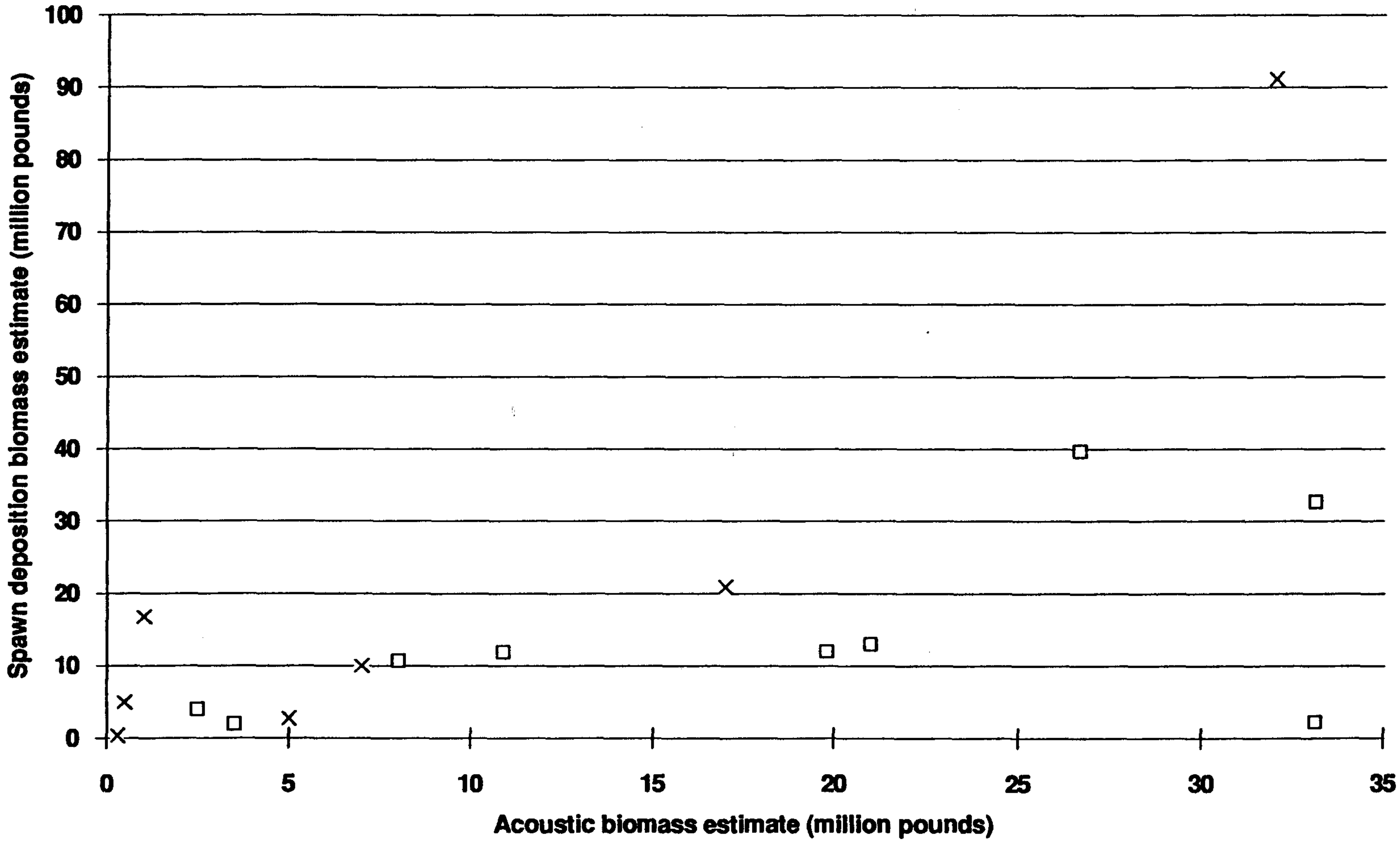


Figure 8. Relationship between biomass estimates estimated simultaneously by spawn-deposition and acoustic methods. Points denoted by an 'X' indicate estimates made visually from acoustic equipment; points denoted by squares indicate computer-aided estimates from acoustic equipment. The R-square value for the relationship between acoustic and spawn-deposition methods was 0.61 (P = 0.013).

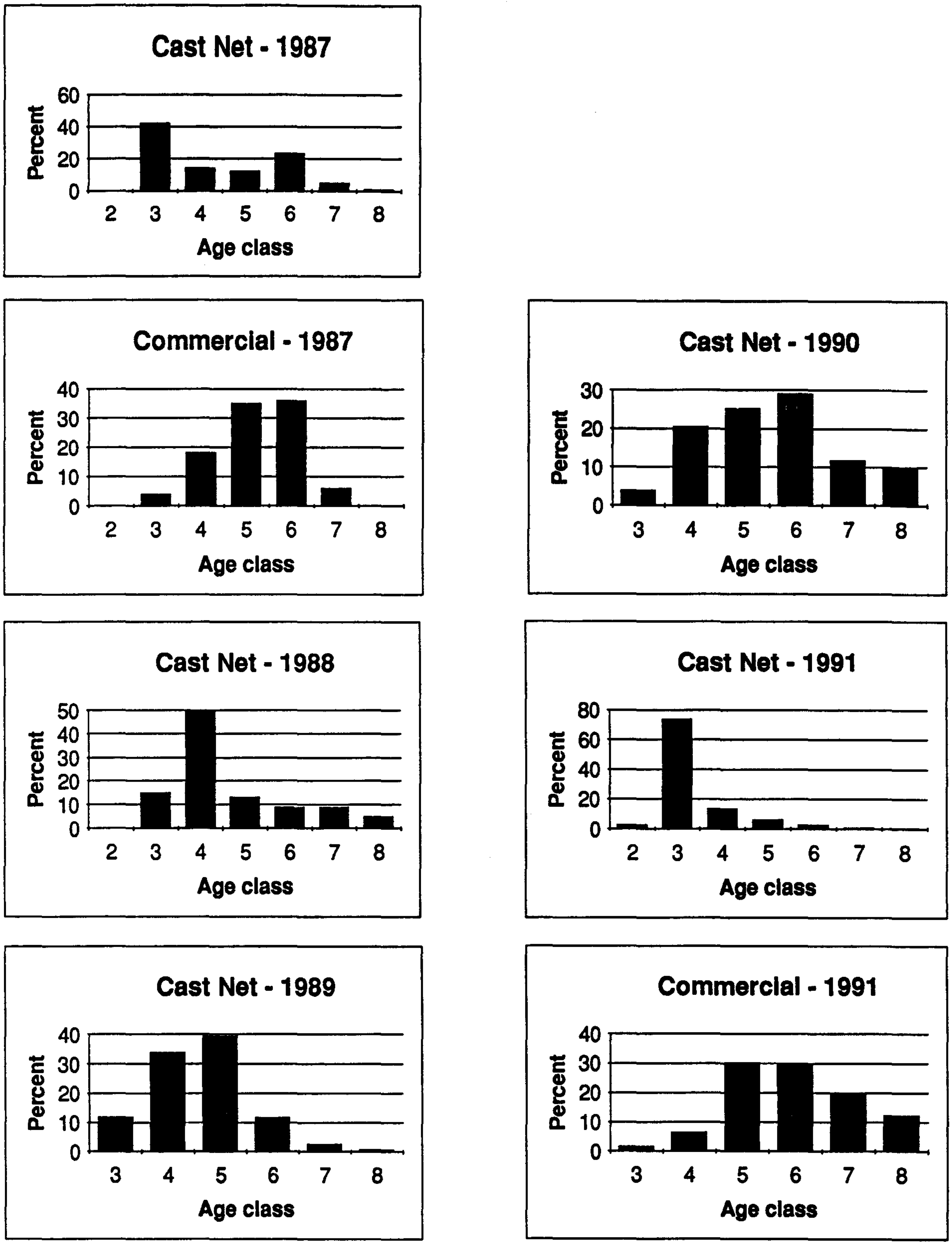
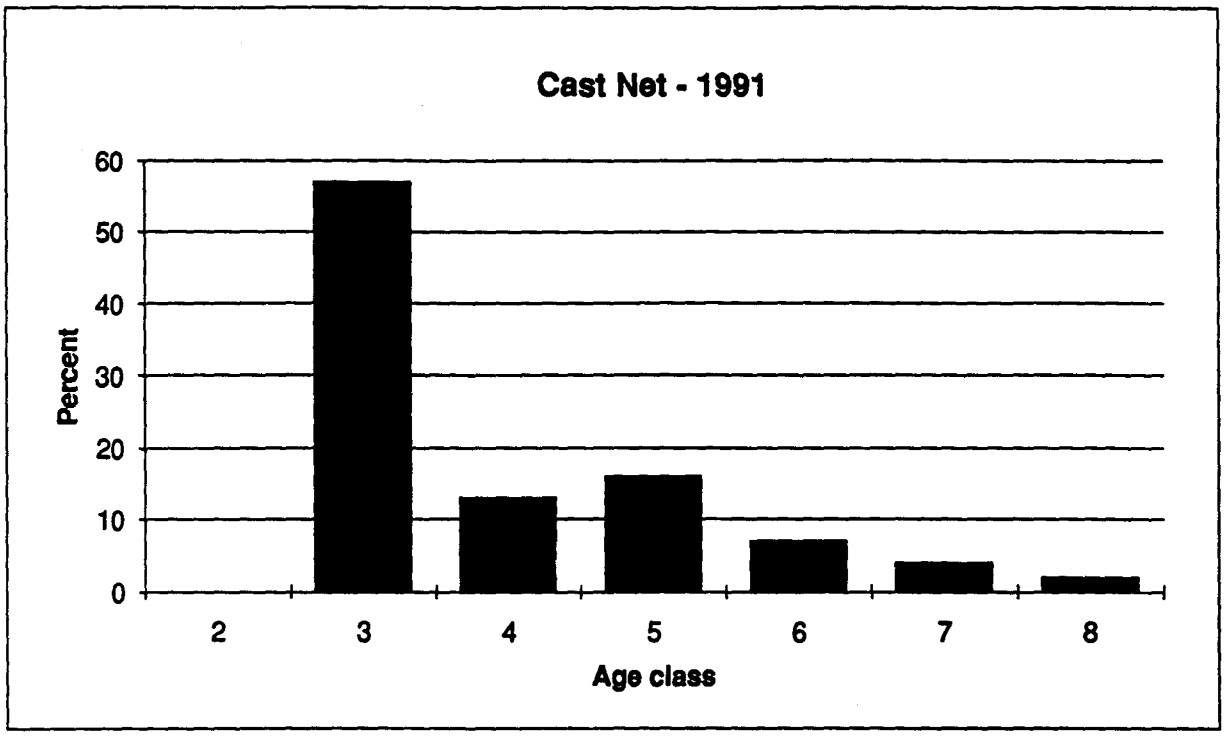


Figure 9. Kah Shakes area herring age compositions, 1987 - 1991.



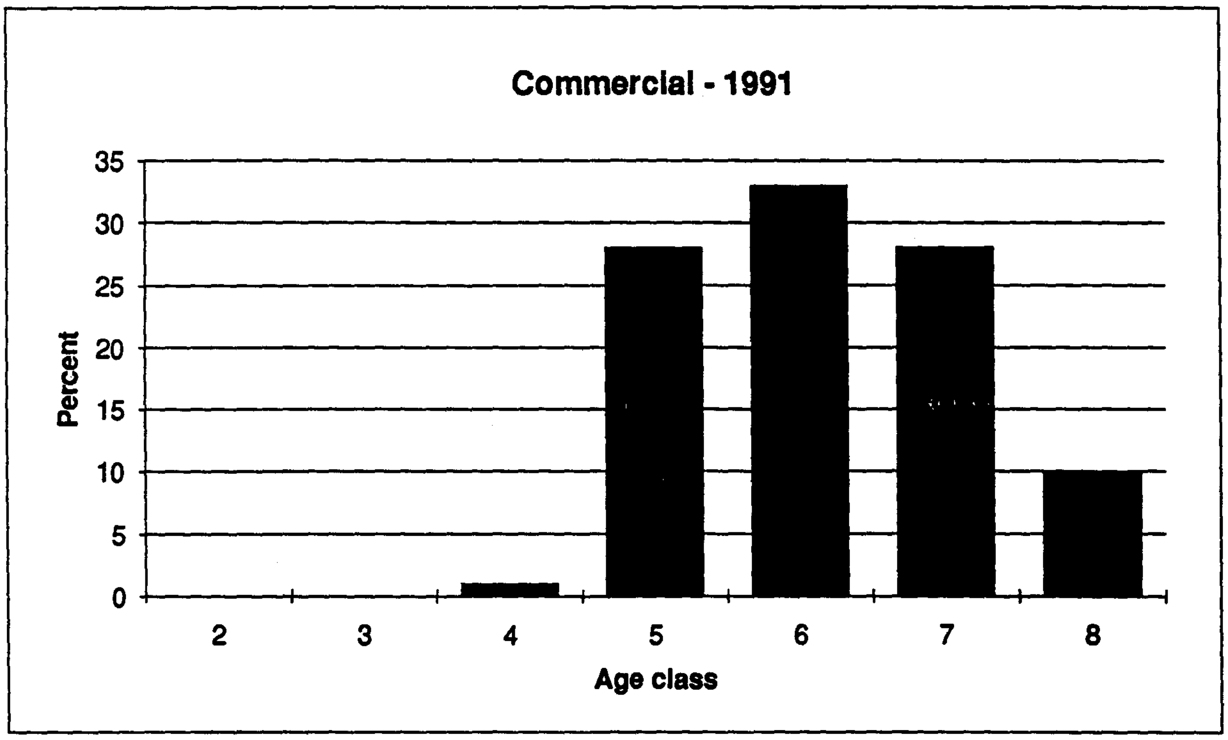


Figure 10. Cat Island herring age compositions, 1991.

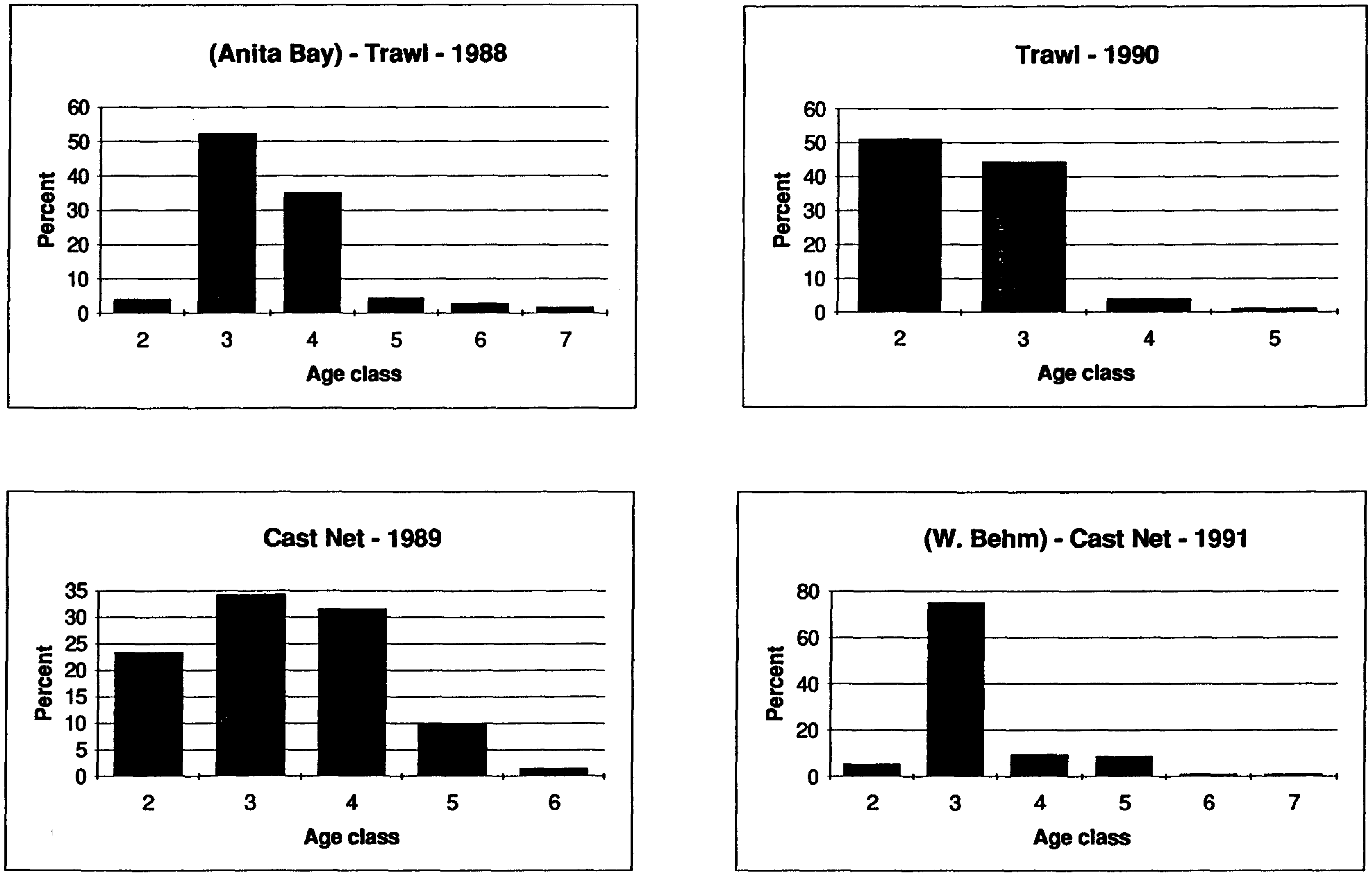


Figure 11. Ketchikan area herring age compositions, 1988 - 1991.

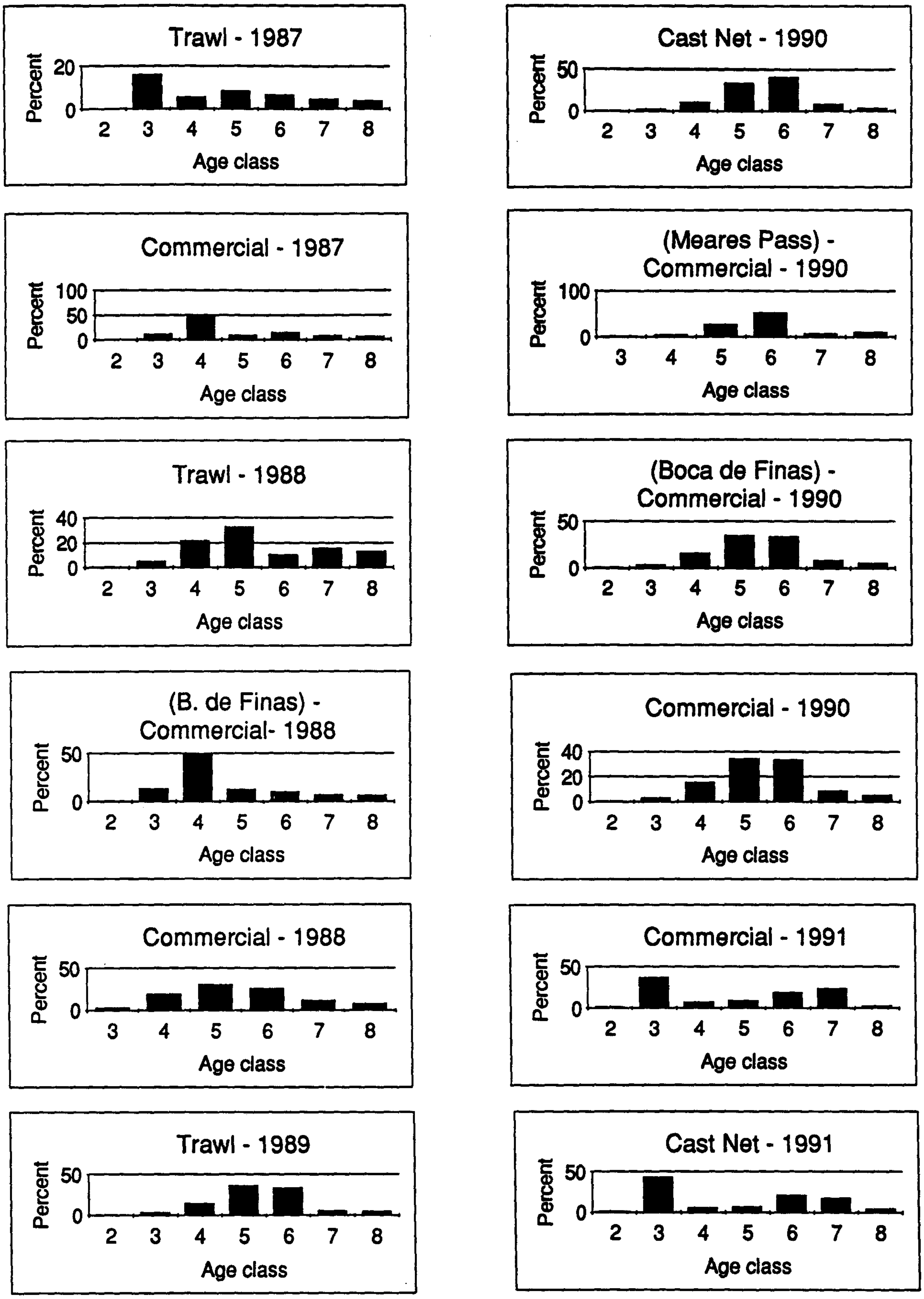


Figure 12. Craig area herring age compositions, 1987-1991.

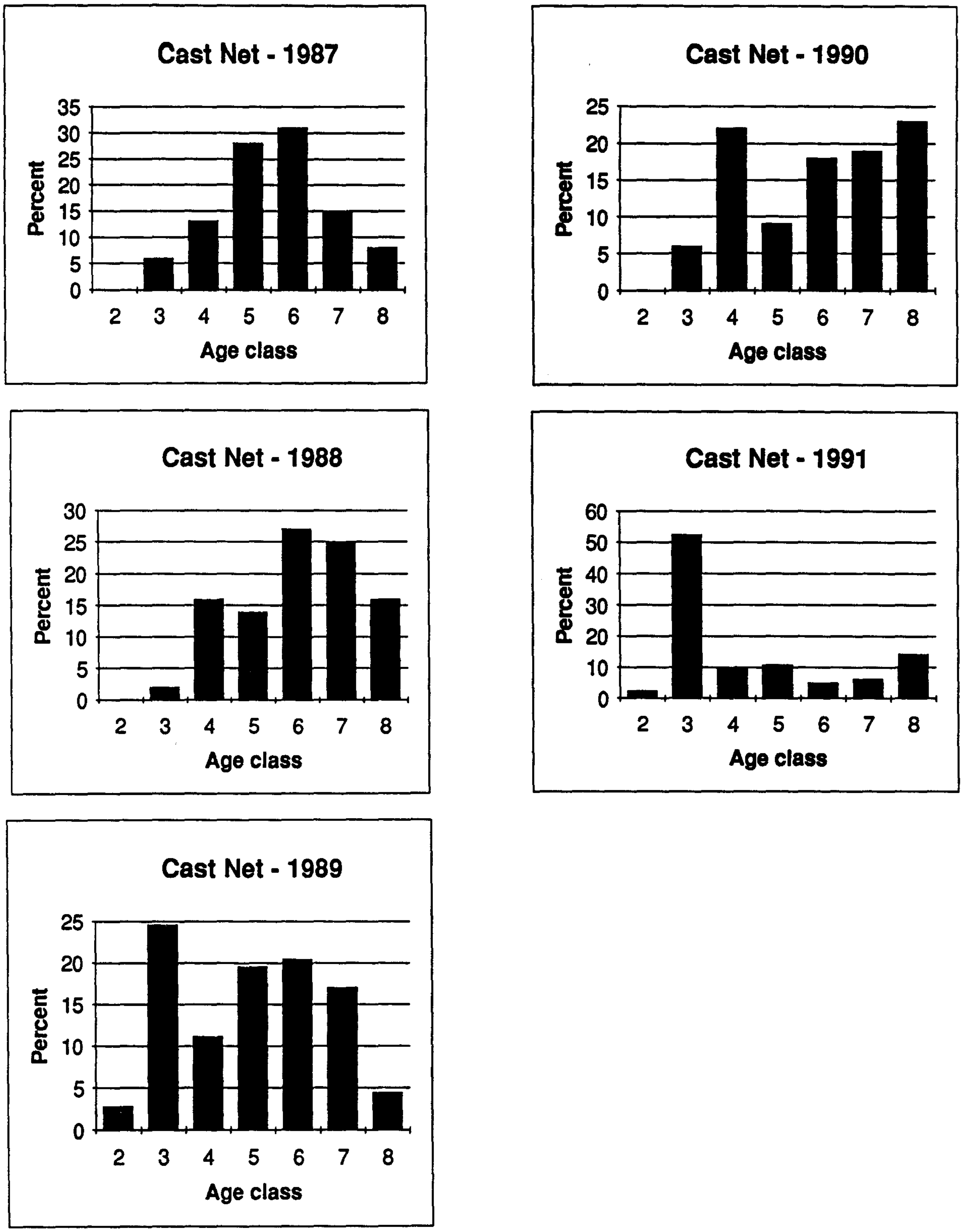
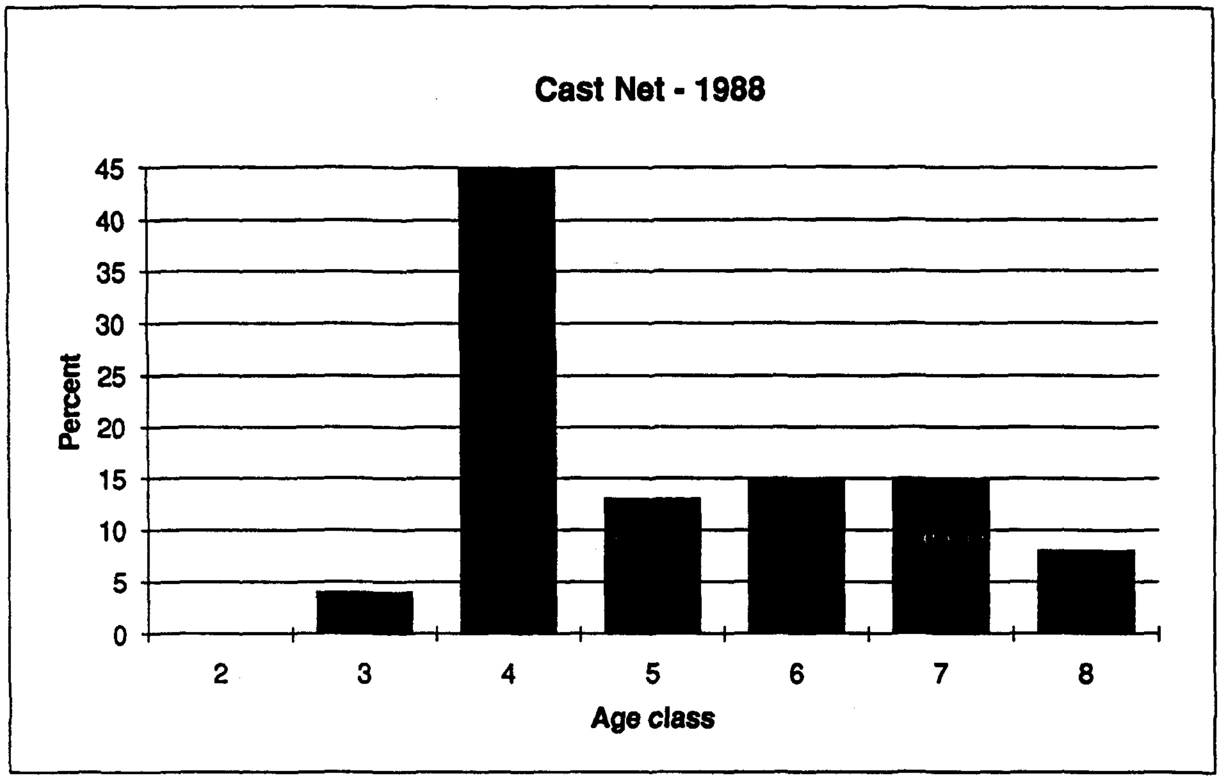


Figure 13. Seymour Canal area herring age compositions, 1987 - 1991.



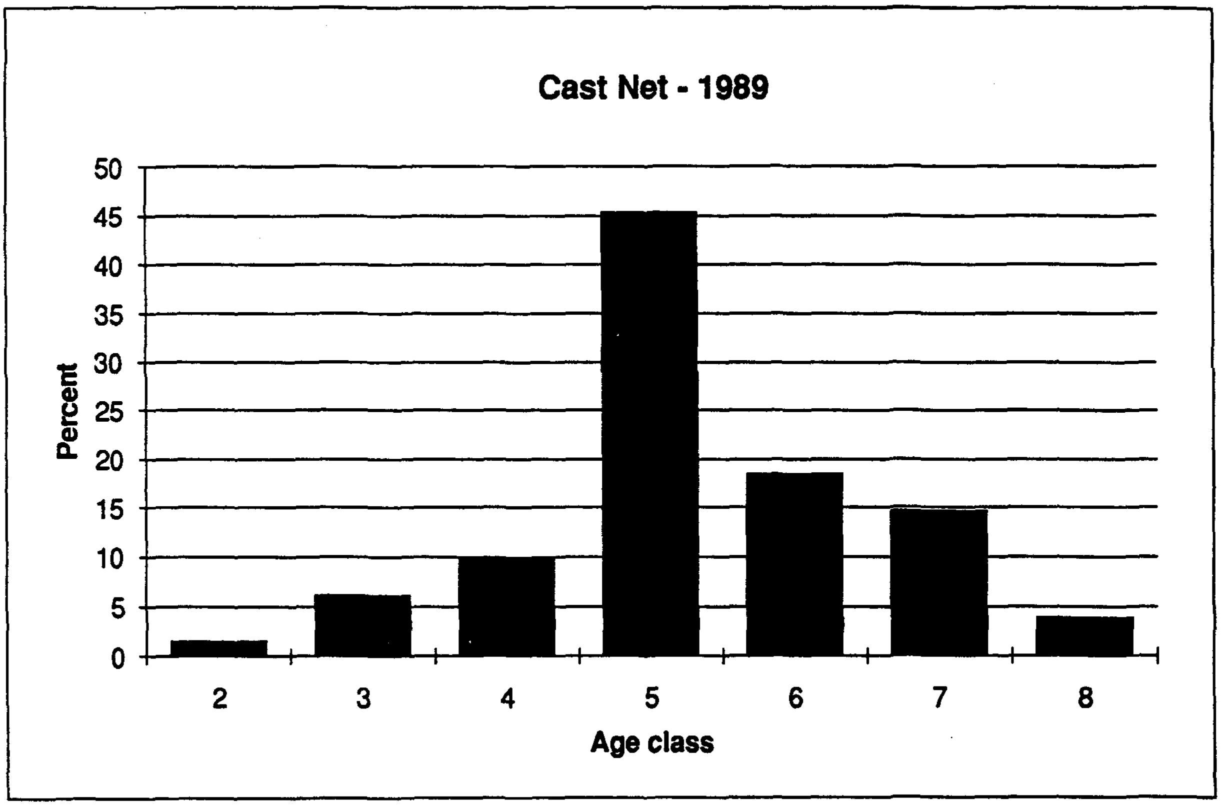


Figure 14. Juneau area herring age compositions, 1988 - 1989.

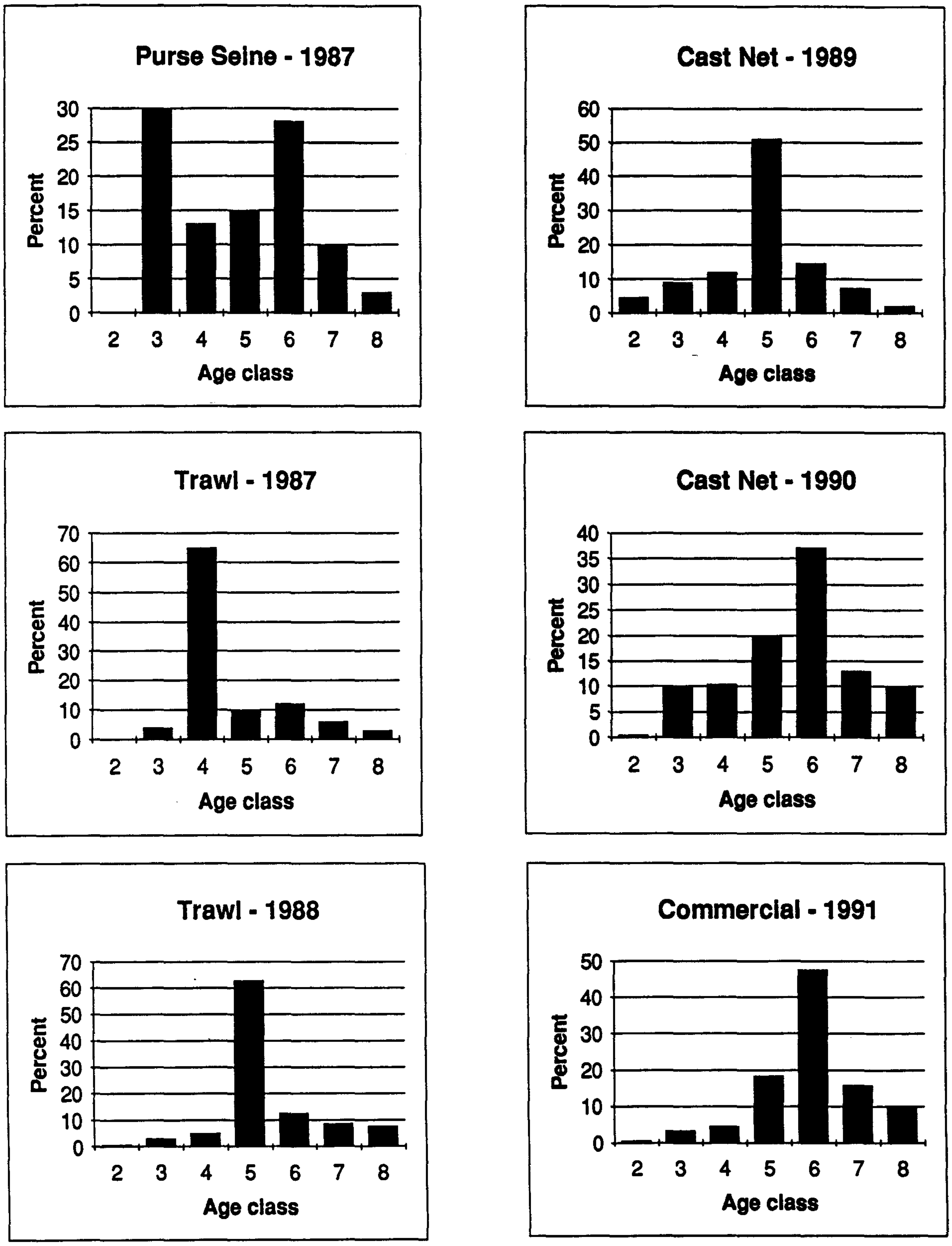


Figure 15. Tenakee Inlet area herring age compositions, 1987 - 1991.

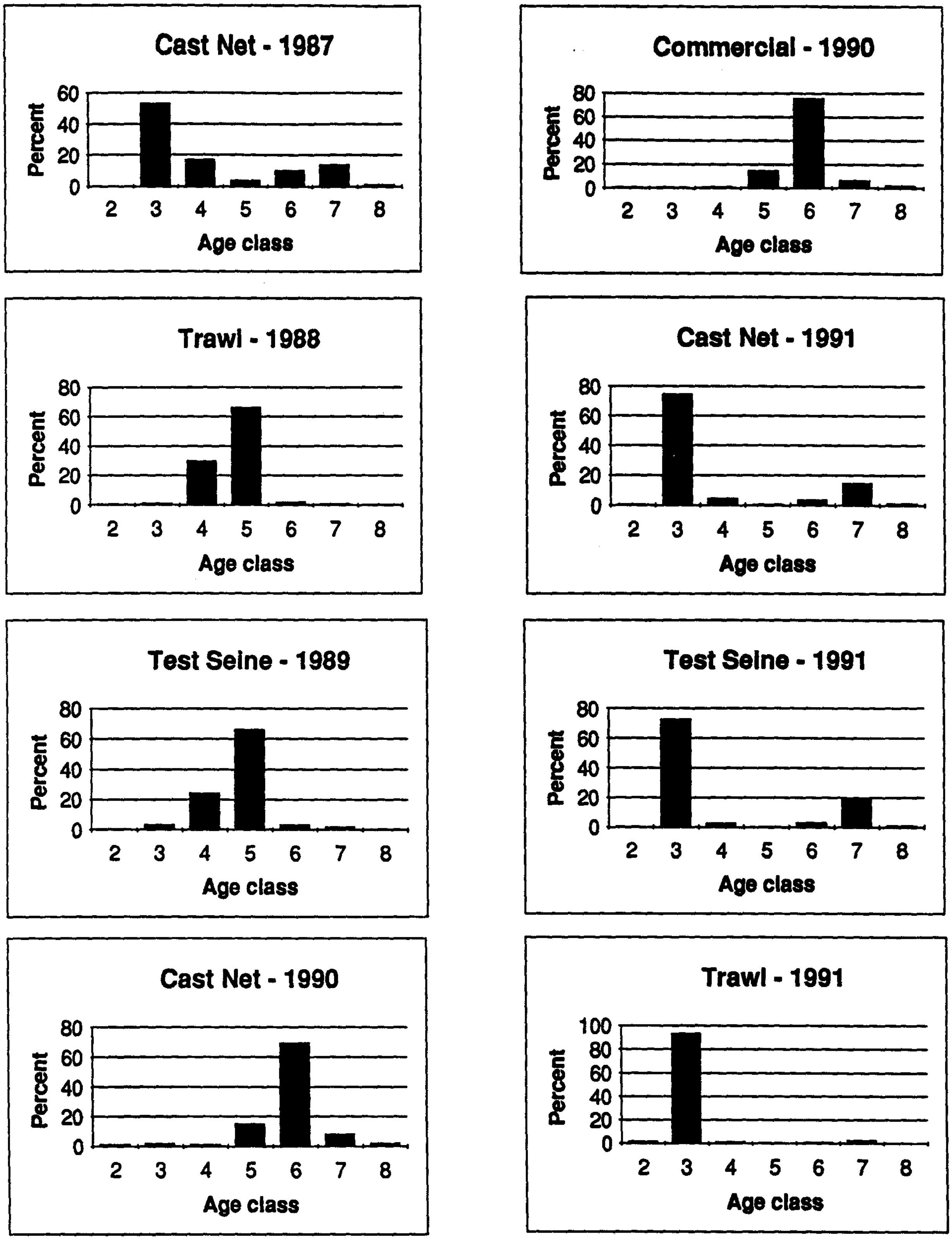
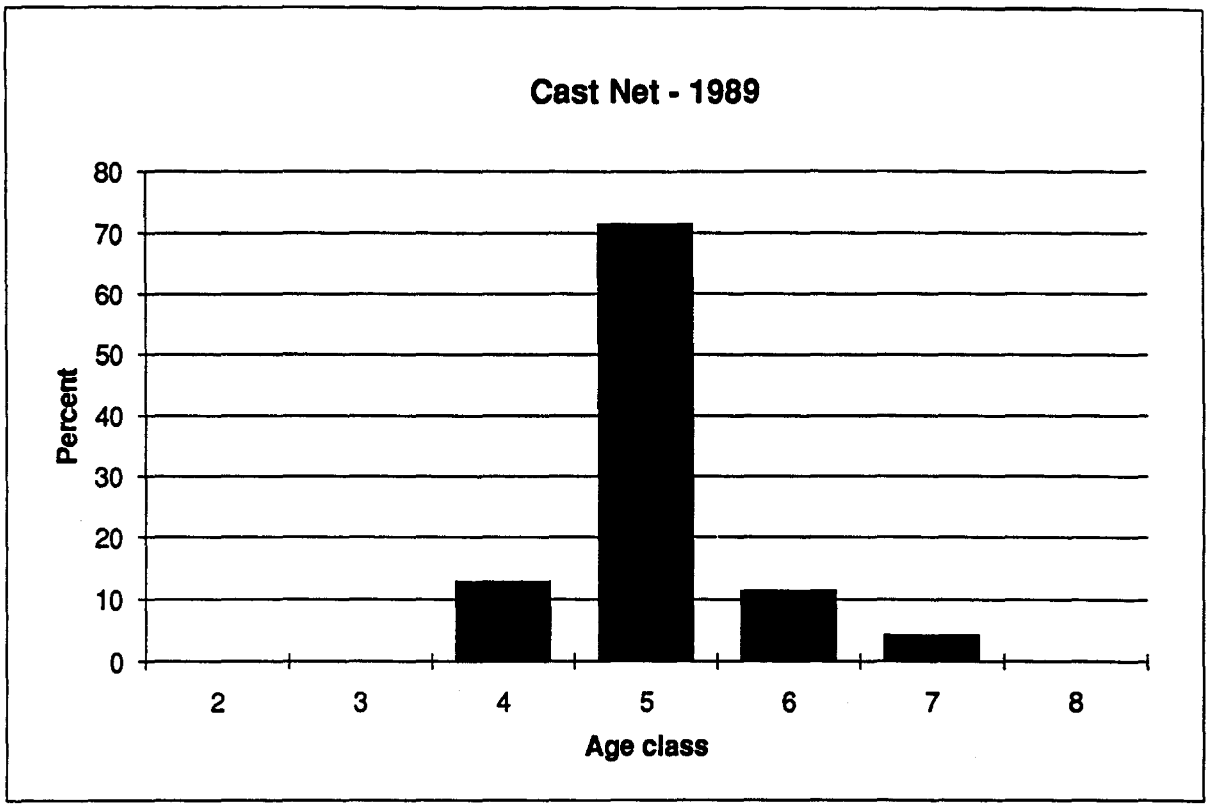


Figure 16. Sitka herring age compositions, 1987-1991.



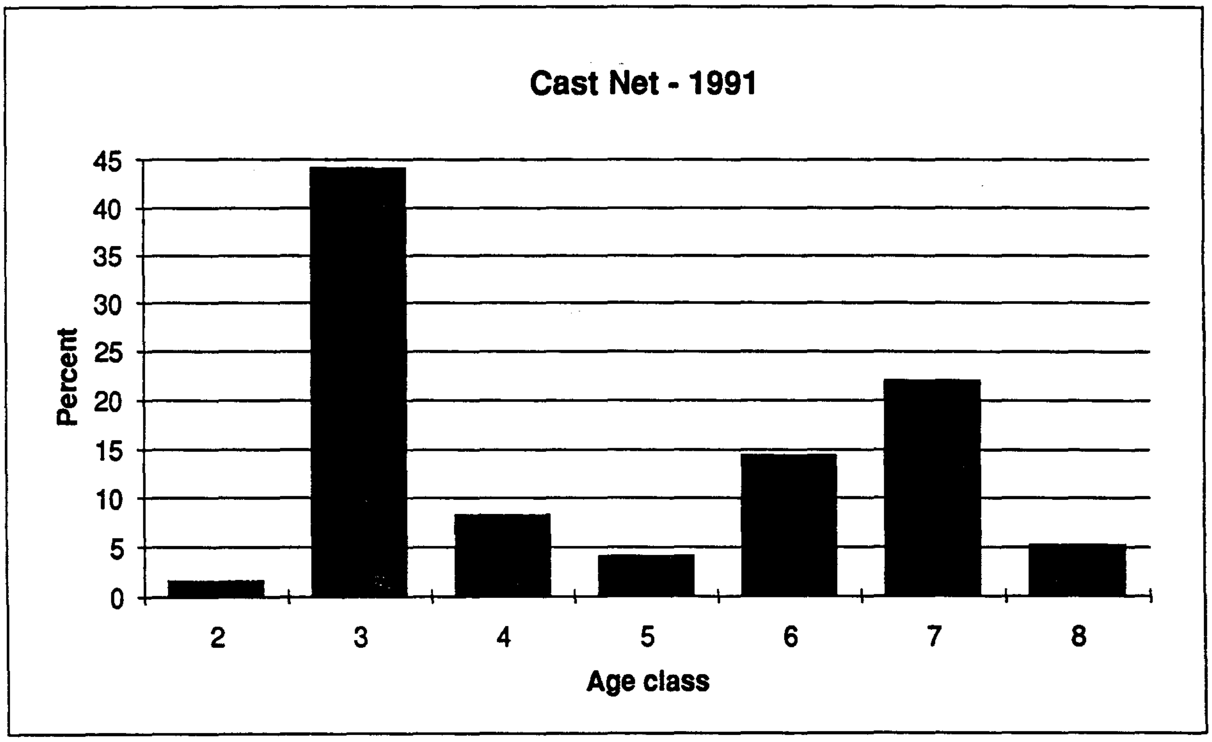


Figure 17. Hoonah area herring age compositions, 1989 and 1991.

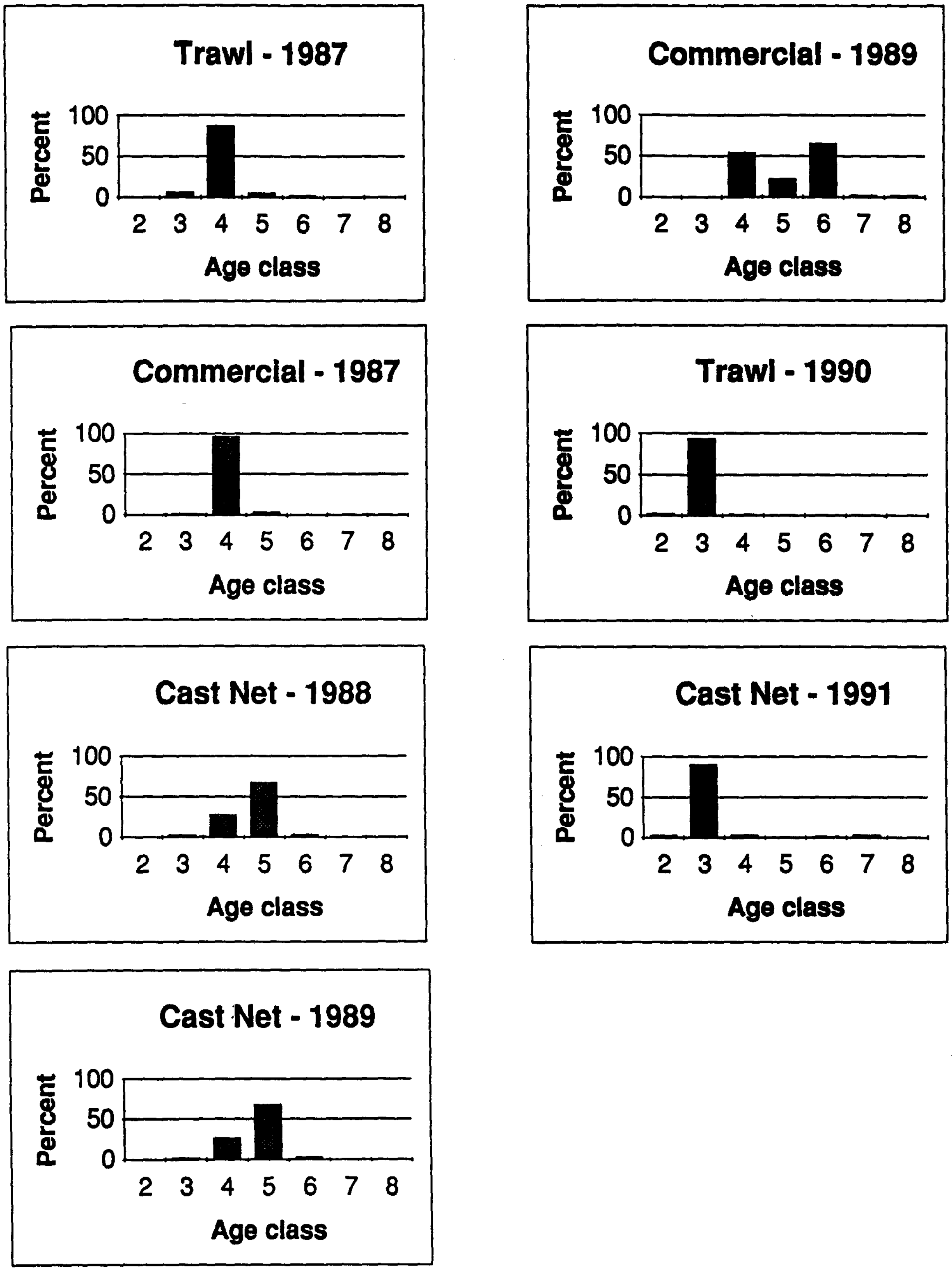


Figure 18. Lisianski area herring age compositions, 1987-1991.

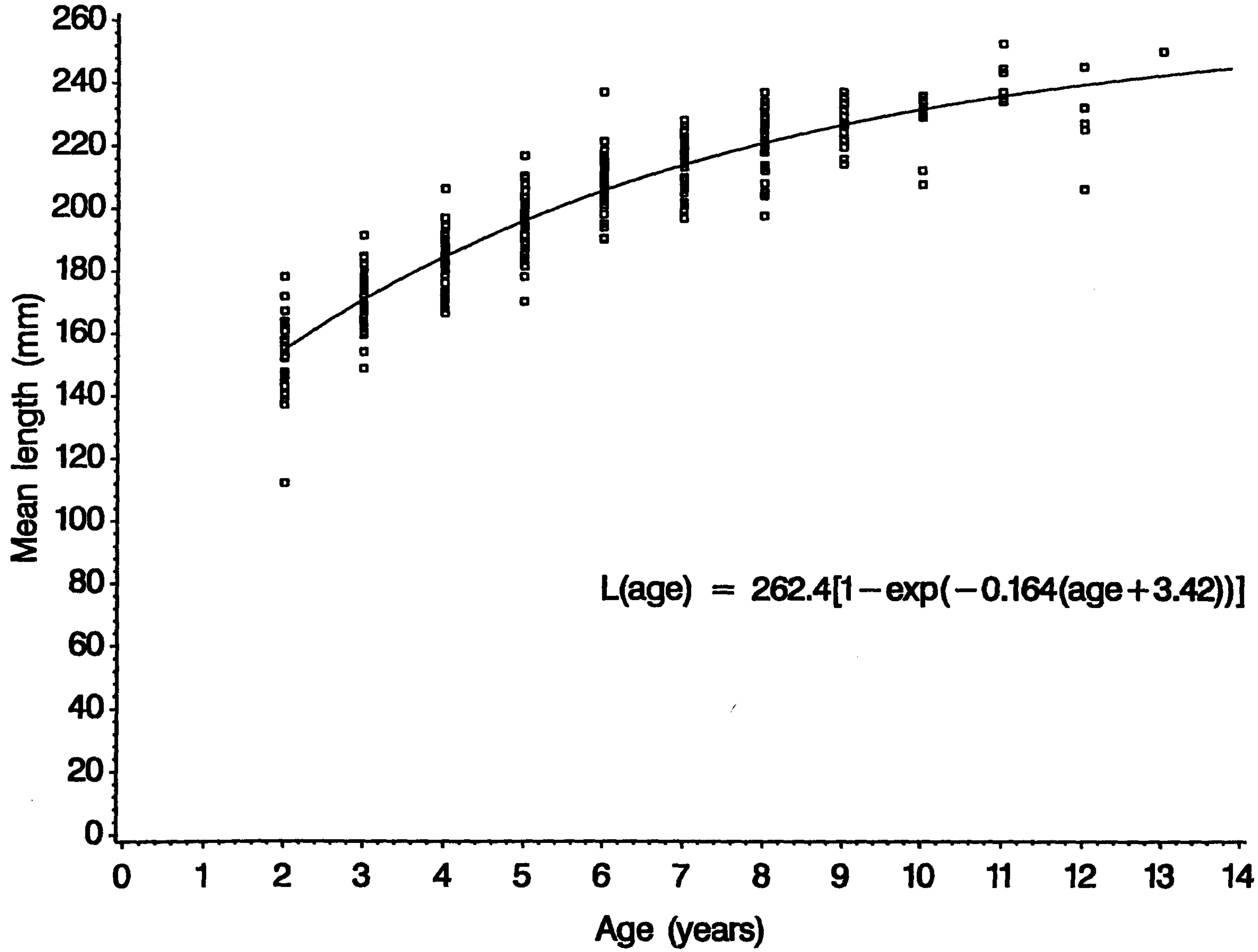


Figure 19. Southeast herring length-age relationship based on a von Bertalanffy growth model. Data from commercial and research samples, 1987-1991, are included in estimating the model parameters.

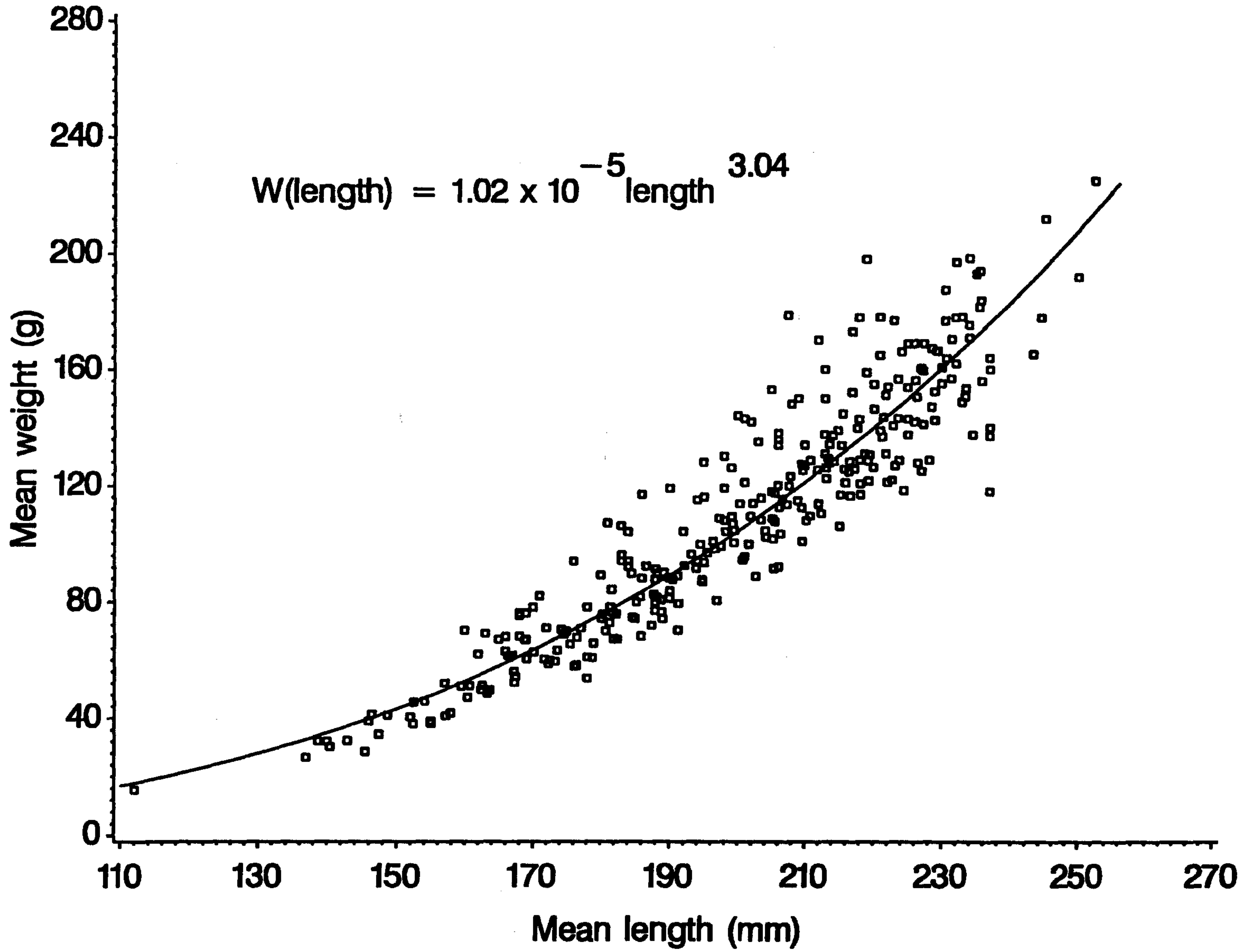


Figure 20. Southeast herring weight-length relationship based on an allometric model. Data from commercial catch and research samples, 1987-1991 were included to estimate the model parameters.

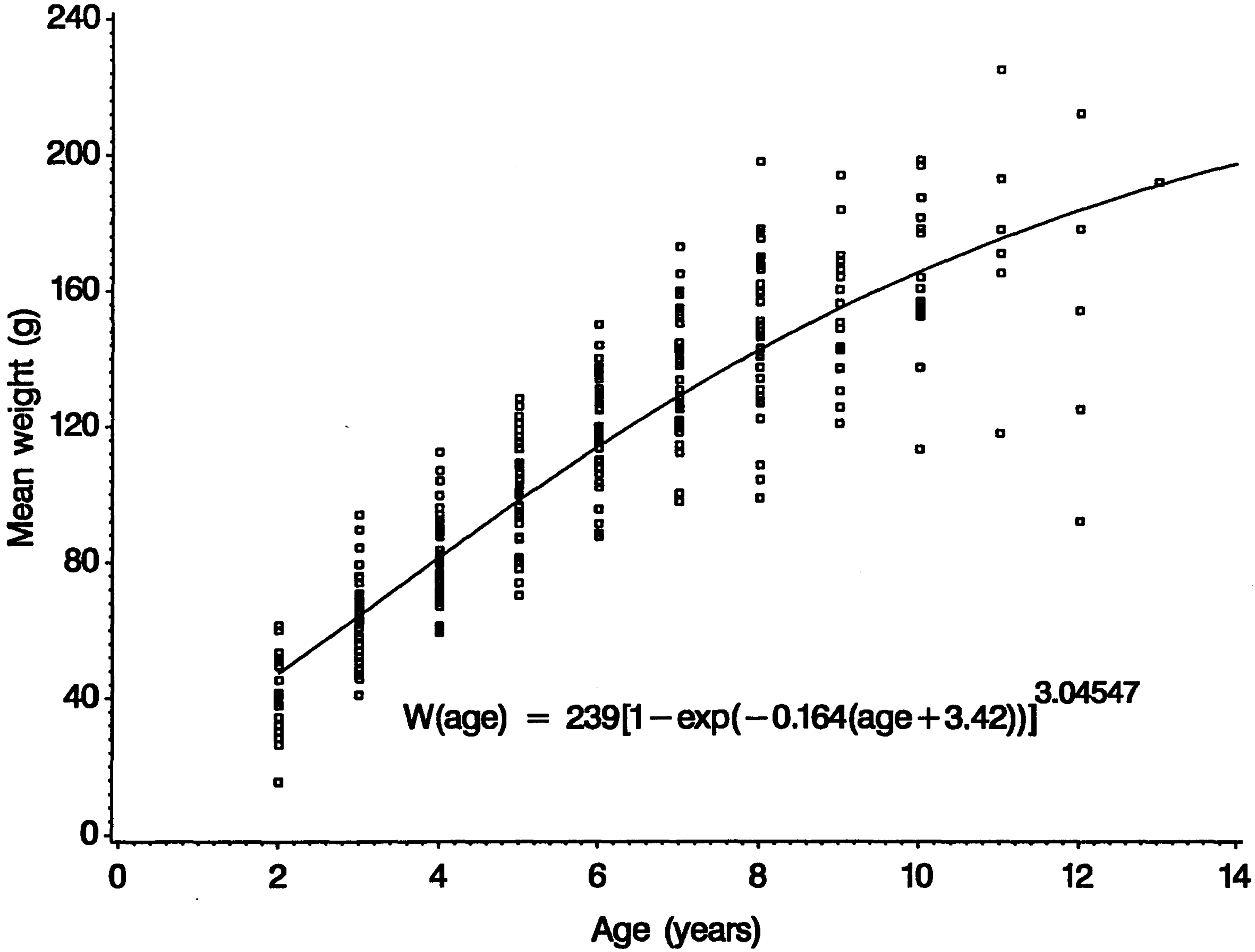


Figure 21. Southeast herring weight-age relationship based on von Bertalanffy weight-age model. Data from commercial catch and research samples, 1987-1991, were used to estimate the model parameters.

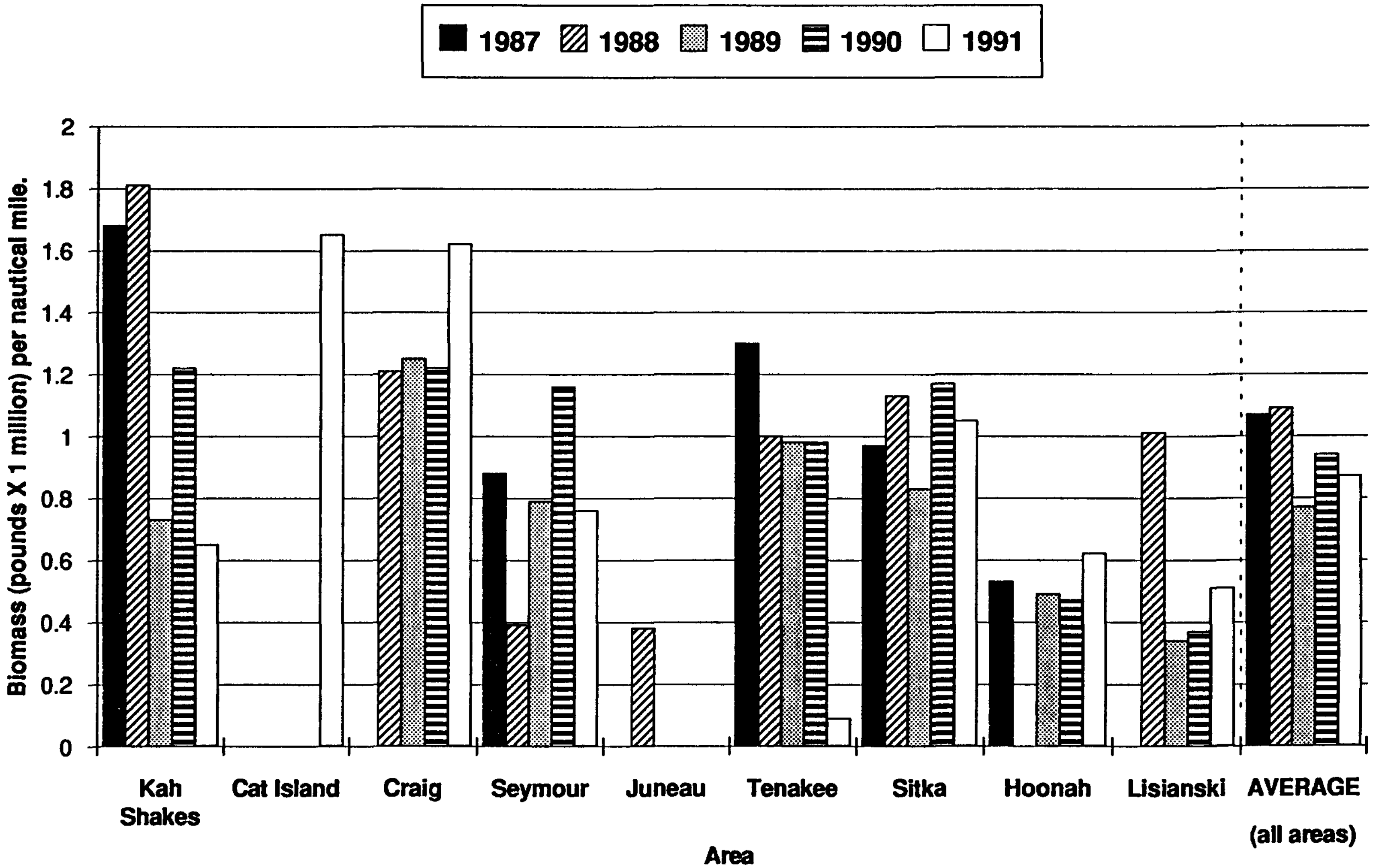


Figure. 22. Estimated biomass (million pounds) of herring spawning per lineal nautical mile of beach.

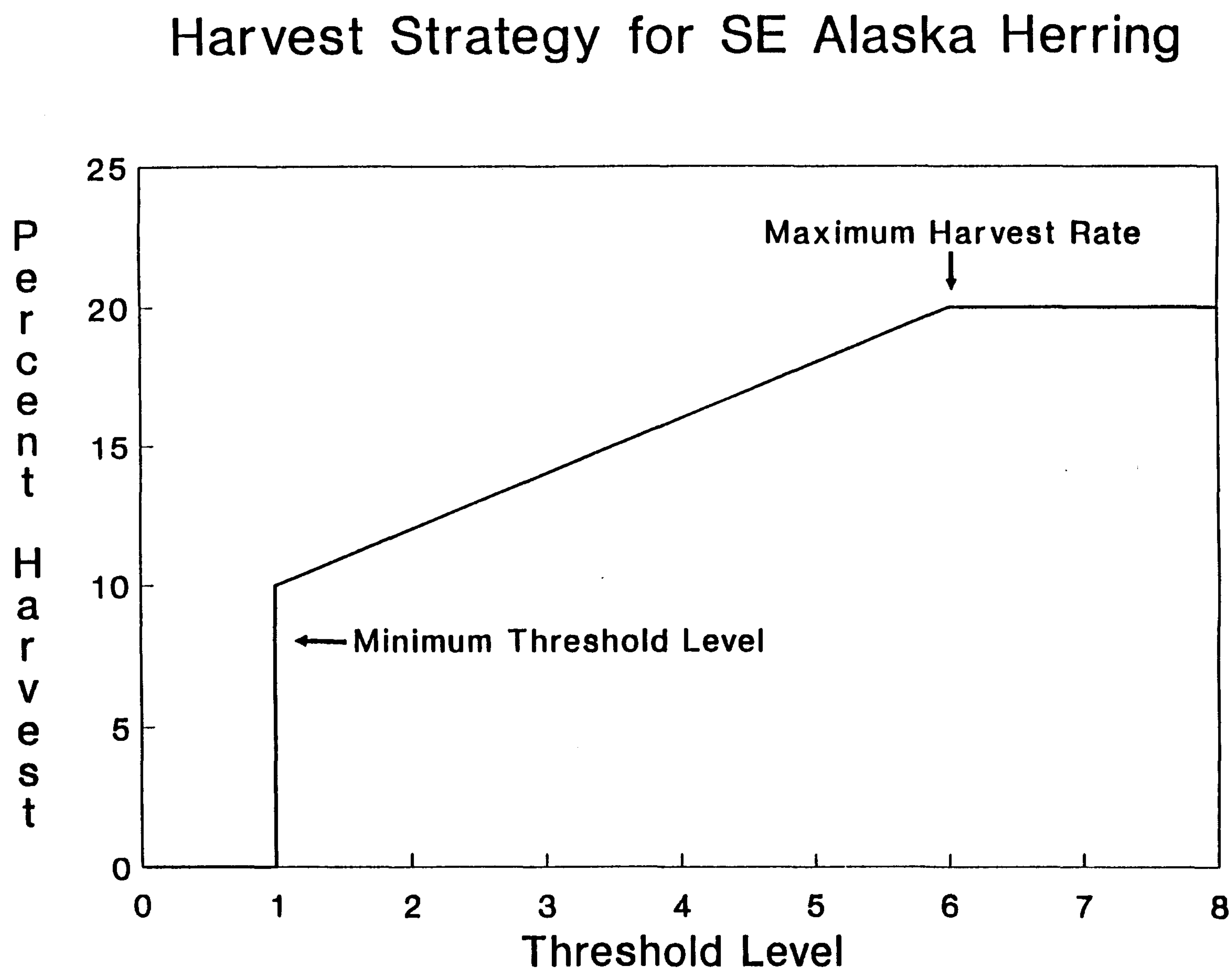


Figure 23. Harvest strategy for Southeast Alaska herring stocks showing allowable percent harvest of the biomass of mature stocks based upon the established harvest threshold level.